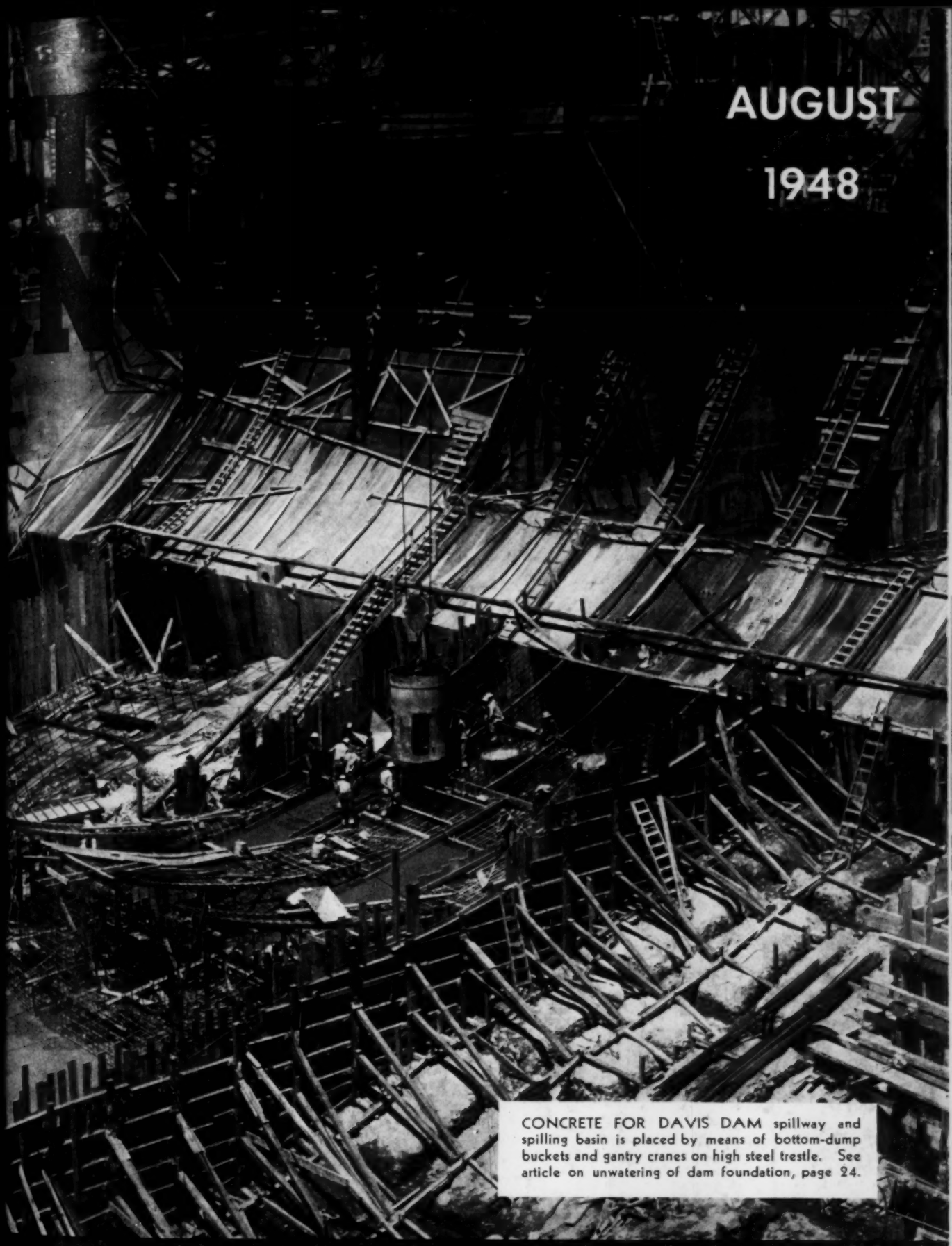

AUGUST

1948

CONCRETE FOR DAVIS DAM spillway and spilling basin is placed by means of bottom-dump buckets and gantry cranes on high steel trestle. See article on unwatering of dam foundation, page 24.

Pacific Coast Issue

Proposed Program Develops Columbia River Basin for Irrigation

North Santiam Highway Follows Difficult Route in Cascades

Construction of Two New San Francisco Bay Crossings Is Directed

Precast Concrete Units Used in West Coast Marine Structures

. . . FOR ITS GIRARD POINT WHAR

. . . once again GULF OIL calls on RAYMOND

The Project

For the fourth time in 28 years, the Gulf Oil Corporation entrusted to Raymond the construction of a new wharf at its Girard Point Refinery on the Schuylkill River near Philadelphia. The work included the removal of an old wooden bulkhead and the construction of a new concrete wharf. The wharf consisted of a reinforced concrete deck involving 2300 cubic yards of concrete supported on 400 precast concrete piles up to 85 feet in length with approximately 300 precast concrete sheetpiles 21 feet in length. Included in the project was the construction of a fender system, the electrical installations, the mooring bollards and the dredging of the river bottom to a depth of 36 feet along the face of the wharf.

Raymond's reputation in the industry is based on satisfied clients and repeat orders of this kind.

51 YEARS — FOUNDED 1897 — OF PROGRESS

THE SCOPE OF RAYMOND'S ACTIVITIES includes every recognized type of foundation construction—concrete, composite, precast, steel, pipe and wood piles. Also caissons, underpinning, construction involving shore protection, shipbuilding facilities, harbor and river improvements and borings for soil investigation.

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Far-Western Projects Hold Spotlight at Seattle Technical Sessions

PROJECTS of current engineering interest in the Far West were described and discussed at the technical sessions held in connection with ASCE's Seventy-Sixth Annual Convention in Seattle, July 21 and 22. Following the President's Annual Address (see page 59) on Wednesday morning, July 21, Eugene L. Grant, Professor of Economics of Engineering at Stanford University, sounded a major theme of the meeting in his paper on "Economic Aspects of Development of Columbia River Power" (see page 63). At the technical sessions that followed on Wednesday afternoon and Thursday morning and afternoon, seven Technical Divisions of the Society presented comprehensive programs.

In all, there were ten Technical Division sessions. On Wednesday afternoon the Air Transport, Engineering Economics and Construction Divisions held sessions. On Thursday morning programs were presented by the Power, Structural and Waterways Divisions; and Thursday afternoon the Construction, Power, and Structural Divisions held their second sessions concurrently with the meeting of the Soil Mechanics and Foundations Division.

Large Western Projects Are Described at Two Sessions of Construction Division

SEVEN PAPERS featured two sessions of the Construction Division, held Wednesday and Thursday afternoons, with Kirby Smith, New York, chairman of the Division's executive committee, presiding.

For the first meeting, papers were prepared by: A. H. Ayers, engineer, Utah Construction Co., San Francisco, Calif., on "Unwatering of Davis Dam"; L. V. Downs, associate engineer, U.S. Bureau of Reclamation, Grand Coulee Dam, Washington, on "Construction for Columbia Basin Irrigation"; and R. B. Rothschild, Jr., Haas & Rothschild, San Francisco, Calif., on "Unit Price Bids." All these papers appear in this issue.

A. H. Ayers

Describing the work involved in the unwatering of Davis Dam, Mr. Ayers told of the contract awarded to the Utah Construction Co. of San Francisco following advertisement for bids by the Bureau of Reclamation in May 1942; how, after extensive plant and equipment had been assembled, and forebay channel excavation begun at the downstream end, the contract was terminated because of wartime equipment and material priorities; and how, after the war, the Bureau again advertised the work in December 1945, and the Utah Construction Co. again was the low bidder for this earth and rockfill structure.

Mr. Ayers' article presents a discussion of the tests conducted to show what method of unwatering would be effective and a description of the wellpoint installation which has been decided on as the only feasible means of removing the large amount of water found near the surface in the foundation area.

L. V. Downs

Rising labor and materials prices have skyrocketed the estimated ultimate cost of the Columbia Basin project in central Washington 40 percent since 1940, with the result that while the halfway mark of physical accomplishment and use of labor has been passed, the project is only 37 percent completed in point of expenditures.

This was brought out by Mr. Downs in detailing the work during the past 15 construction seasons on the project for irrigating more than a million acres by delivering to them 3,920,000 acre-ft of water annually. Mr. Downs said:

"Construction of the irrigation works required has some promise of completion within a total work span of one generation. In comparison with some of the wartime construction records, this may not seem to be noteworthy. However, in comparison with other irrigation developments, it is indeed unprecedented."

Mr. Downs cited the ultimate actual capacity of 2,300,000 kw to be derived from the development of hydroelectric generating facilities at Grand Coulee as one of the primary benefits of the project, and pointed out downstream power plants, navigation, flood control, conservation and recreation as incidental benefits.

R. B. Rothschild, Jr.

Improvement of bidding forms as one method of holding down construction costs was urged by Mr. Rothschild, who called upon engineers to prepare better bidding forms as their contribution toward a meeting of minds between owners and contractors. He stated:

"The unit bid form is the most expedient way of arriving at a solution on heavy construction and other types of projects where the hazards are of great consequence. However, in the past, many unit bid forms have lost sight of their purpose and have become merely a mathematical nightmare for the contractor instead of reducing his hazards."

Second Session

At the second Construction Division session, papers prepared by the following were presented: Col. O. E. Walsh, Corps of Engineers, District Engineer, Portland, Ore., "Construction of Willamette Valley Flood Control Project"; J. F. Cameron, Senior Highway Engineer, Public Roads Administration, Portland, Ore., "Unusual Design and Construction Features of North Santiam Highway"; O. H. Tucker, Jr., Project Manager, Macco Corp. and Morrison-Knudsen Co., Inc., San Bruno, Calif., "A Large Earthmoving Project"; and Ben C. Gerwick, President, Ben C. Gerwick, Inc., San Francisco, Calif., "Building a Concrete Causeway with Precast Units."

J. F. Cameron

Because of the extreme difficulties it presents, the 15-mile, $5,700,000 North Santiam highway project

under construction in the foothills of the Cascade Mountains of Oregon belongs in the category of earthmoving undertakings accomplished by hand 4,500 years ago in great ceremonial structures, Mr. Cameron asserted in his presentation. Stressing the importance of the route to the present and future development of Oregon, and the fact that it provides the shortest connection between the crowded cities and productive farms of the Mid-Willamette Valley and a comparatively unsettled central eastern area having great stands of timber and large areas of fertile soil, Mr. Cameron said:

"This 15-mile project is costing an average of $380,000 a mile. One of those miles will cost $770,000. When one examines the singular conditions under which this project was designed, the rugged terrain over which it is being built and the peculiar difficulties encountered in its construction, that figure shrinks to reasonable proportions. Mr. Cameron's paper appears on page 40 of this issue.

O. H. Tucker, Jr.

"Contractors must plan their work in the same manner as engineers in order to correlate their operations," Mr. Tucker declared in his paper describing the joint-venture activities of the two concerns with which he is associated in contracts for hauling the millions of cubic yards of fill required for enlarging Mill's Field, now known as the San Francisco International Airport. His paper describing the assembly-line techniques evolved for speedy and economic operations, appears in this issue, page 52.

Ben C. Gerwick

"Utilization of precast concrete methods in marine structures makes possible faster construction, greater economy, gives superior results, and greater labor productivity," Mr. Gerwick said in his paper, presented from the viewpoint of the contractor rather than from that of design or final use.

Mr. Gerwick's paper, centered around the construction of the Standard Oil Co. of California's Long Wharf at Point Richmond, Calif., appears on page 46 of this issue.

Cost Allocation for Multiple-Purpose Projects Is Discussed by Engineering Economics Division

A PROCEDURE for allocating costs of multiple-purpose water developments, involving billions of dollars of federal expenditures, was proposed at the General Session on Cost Allocation conducted under the sponsorship of the Engineering Economics Division. Charles H. Blackman, Louisville, Ky., a member of the Division's Executive Committee, presided.

The recommended engineering techniques also cover the testing of the economic justifiability of such undertakings and are designed to help standardize the financial analysis of huge projects like the Hoover and Grand Coulee Dams of the Bureau of Reclamation, Bonneville Dam of the Corps of Engineers of the Army, and the system of dams of the Tennessee Valley Authority.

Components of multiple-purpose water projects, such as irrigation, flood control, navigation, and power, can and should be made to bear their proper share in cost allocation, with greater protection to taxpayers through disclosure of all subsidies, it was held in a committee report submitted by Col. F. W. Scheidenhelm, New York consulting hydraulic engineer, chairman of a joint committee in which representatives of four Society Divisions participated. These are the Irrigation, Power, Waterways, and Engineering Economics Divisions, with the latter sponsoring the committee.

Formed eight years ago, the committee has been continuously studying the problem of multiple-purpose water developments, with the exception of a period during the war. As was brought out in the report, at present the procedures of the government agencies are far from uniform. Eight different current theories under which the cost of these projects, such as dams and reservoirs built for any combination of flood control, irrigation, navigation and power, may be allocated, were studied by the committee. Each of the theories is carefully examined in the voluminous report and appendix submitted by the group as a tentative report.

A "Proportionate Use of Capacity" method is recommended in the report, which points out that, because of the complexities of the subject, such an apportionment must be considered as preliminary to an adjustment which may be desirable and justifiable in certain instances. The outcome in any case is styled as "definite allocation." The method recommended for the preliminary apportionment distributes joint costs upon the basis of comparative use of the joint facilities, such as dams, reservoirs and water conduits.

After assignment of costs to any incremental components or functions not essential to the primary components, the remaining cost of the project is divided among those components serving the primary purposes. This is done by assigning to each that part of the cost which is incurred exclusively on account of that primary component and thereafter prorating to each a share of the remaining joint costs in proportion to the respective extents of use of the joint facilities by the several components.

An important adjunct to this procedure recommended by the committee is that, in order to insure economically justified projects, the value resulting from each of the component parts shall be substantially in excess of the cost allocated to that component.

The report makes it clear that complexities presented in various problems related to multiple-purpose water developments do not lend themselves to the ready allocation of costs which is attainable, for example, in the railroad field, where cost apportionment between freight, mail, express and passenger business may be made upon some comparable use units like car-miles, passenger-miles, or ton-miles measure.

In making public the tentative report as a contribution of the committee and the civil engineering profession, the hope was expressed by Society officials that the final report may become the basis of a procedure which will resolve some of the serious questions of economics and finance which have arisen in the water field, particularly since multiple-purpose projects have become a prominent feature of that field of development of the resources of the country.

Under existing national law, costs incurred for flood control and navigation are charged almost entirely to the Federal Treasury and, hence, are paid for by the federal taxpayers. Costs incurred for irrigation are repayable in part to the Treasury, and costs for power development are intended to be repaid to the federal government in full. Obviously, in the case of a multiple-purpose project which happens to include all four purposes, the allocation of cost among them has

possibilities of greatly affecting the costs to be borne, respectively, by the taxpayers at large and by the local beneficiaries or consumers.

Separately, Engineers Joint Council, representing the entire engineering profession—the societies of the civil, mechanical, electrical, mining, and chemical engineers—has, at the suggestion of the American Society of Civil Engineers, established a committee to explore the possibility of an over-all study leading to the development of a national water policy. Engineers feel that such a policy, if developed and adopted by Congress, should include a rational approach to the allocation of costs of multiple-purpose projects, and the work of the joint Division committee is closely related to the national water policy problem.

In addition to Colonel Scheidenhelm, members of the committee making the report, and their specialties as to the work of the committee, are: Col. Malcolm Elliott, St. Louis, Mo., navigation; L. L. Hidinger, Memphis, Tenn., flood control; W. W. Horner, St. Louis, Mo., water supply; R. J. Tipton, Denver, Colo., irrigation; and M. W. Torkelson, Madison, Wis., recreation and wild life.

Dam Foundation Studies Receive Attention of Soil Mechanics and Foundations Division

FOUR PAPERS and an opening statement by the presiding officer featured the session of the Soil Mechanics and Foundations Division. Papers were prepared by the following: Neil H. Twelker, Associate Engineer, Seattle District Corps of Engineers, on "Three-Dimensional Seepage Studies at Foster Creek Damsite"; Constantine A. Novie, Associate Engineer, Seattle District. Corps of Engineers, on "Foundation Analysis, Springston Damsite, Coeur d' Alene River, Idaho"; Harry R. Cedergren, Senior Engineer, Portland District, Portland, Ore., on "Analysis of Clay Foundation, Meridian Damsite, Willamette River, Oregon"; and Alexander Hrennikoff, Assistant Professor of Civil Engineering, University of British Columbia, on "Analysis of Pile Foundations with Batter Piles." Allen S. Cary, chairman of the Seattle Section's Soil Committee, presided and presented some remarks on "Geology of the Foster Creek Damsite."

Allen S. Cary

The Foster Creek Damsite, 51 miles downstream from Grand Coulee Dam, on the Columbia River, is being studied for power development by the Seattle District, Corps of Engineers, for the utilization of about 165 ft of available head between the Coulee Dam tailwater and the Foster Creek rapids, Mr. Cary said.

"Early in the exploration program," he declared, "it became apparent that the pervious gravel on the right bank constituted a major factor in the design of the structure. Exploration was therefore centered upon it, without, however, losing sight of the fact that the glacial till also may show marked variations, some of which could prove detrimental to the proposed undertaking."

Mr. Cary described the exploration work accomplished by means of drill holes, trenches and test pits, tunnels, and stopes, and explained how the exploration was directed toward "learning first, the truth of the origin of the various strata; second, the variations that could be expected within the various materials; third, the magnitude and extent of any single member; and fourth, the engineering implications of the findings."

Neil H. Twelker

In his paper, Mr. Twelker asserted: "The percolation path of water in the right abutment at Foster Creek Dam will be *around* the end of the cutoff or blanket, and *down*. Thus the nature of the seepage is three dimensional, as opposed to the usual two-dimensional problem encountered by the engineer. The need for a method of analysis of this problem appears in two phases of the project: (1) Dewatering of the foundation excavation and (2) control of leakage from the reservoir."

Mr. Twelker narrated how a mechanical flow net has been devised for this special problem "that will be of great value not only in the solution of three-dimensional flow nets, but in the construction of two-dimensional nets, and should also be of assistance to teachers of the subject."

Activities of Civil Aeronautics Administration Discussed by Air Transport Division

HOW THE CIVIL Aeronautics Administration is endeavoring to coordinate aircraft and airport design in order to hold down construction costs of airport pavements, as well as to provide greater safety for the air transport industry, was detailed in three papers presented before the Air Transport Division. Alfred J. Ryan, Denver, Colo., presided at the meeting at which CAA men presented data on recent steps taken to improve conditions in the industry.

Henry Aaron

William C. Hill of the Oregon State Board of Aeronautics, reading a paper prepared by Henry Aaron of the CAA, in which was presented a formula for pavement loading designed for various-sized airports, stated:

"Airport engineers have been greatly perturbed over the cost of providing pavements of adequate strength to carry the loads imposed by the large aircraft now being built as well as the larger ones already in the blueprint stage. Some assurance must be given airport officials that when they build an airport it will not soon become obsolete as a result of new developments in aircraft design. At the same time, it will be highly undesirable to restrict the development of larger aircraft by failing to provide suitable airport facilities. It is believed that if aircraft designers would cooperate with airport designers, the construction of airport pavements for very heavy aircraft can be kept to a reasonable cost."

How the use of dual wheels and dual tandem gear enables pavement to bear heavier loads was detailed in Mr. Aaron's paper, which presented the CAA's latest permissible loadings.

"It is believed that these runway strength requirements are adequate to comply with the needs of civil aviation in the foreseeable future, if

there is the proper correlation between the design of airports and the design of aircraft," Mr. Hill declared. "Under these conditions, airport officials can feel assured that their landing fields will continue to serve their purpose as advances are made in aircraft design."

Paul H. Stafford and Richard T. Puckey

In a paper prepared by Paul H. Stafford and presented by Richard T. Puckey, runway dimensional standards established by the CAA were portrayed as "providing a greater safety factor which seems to be in line with the trend." Throughout the history of the air transport industry, Mr. Puckey declared, each change in regulation has increased the margin of safety in operating conditions, at least in so far as runway lengths are concerned.

Mr. Puckey called the CAA order "a very important first step in stabilizing the design of airports and aircraft so that each will function efficiently," and added:

"Aircraft designers and operators now have a criteria for the selection and design of aircraft types to be used on each route of any airline system. This is a valuable contribution to that segment of the aviation industry. A properly balanced airport system will do much to improve safety, regularity and economy of air transportation."

Everett C. Crites

In the third paper, Everett C. Crites, Chief of the Standards Coordination Division, Airports Engineering Service, Office of Airports, CAA, narrated the steps leading to establishment of the segmented circle airport marker system by CAA as a safety measure to make location of airports easier from the air. He told of exploratory trips on which "we had to circle the field two or three times to locate the wind indicator to determine in which direction we should land. Many times this indicator was a dirty wind sock which was very hard to locate as it blended in with the background of the field."

Standard use of the segmented circle is expected to reduce airport accidents and hazards, and offers an inexpensive improvement in the field of air transport, Mr. Crites stated in his paper.

Power Generation Will Be One of Northwest's Greatest Industries, Division Is Told

POWER DEVELOPMENT in the Northwest was the theme of the Power Division meeting, over which E. H. Collins, Spokane, Wash., chairman of the Division's Committee on Operation and Maintenance of Hydroelectric Generating Stations, presided. Papers were prepared for the meeting by R. Wayne Lincoln, Senior Engineer, Corps of Engineers, Seattle District, on "Potentialities of Coordinated Development of Power in Columbia River Basin"; and by Barry Dibble, consulting engineer, Redlands, Calif., on "Northwest Power Markets."

These papers were followed by a symposium on "The Northwest Power Pool," over which E. N. Peterson, Portland, Ore., coordinator of the pool, presided. Participating in the symposium were: J. O. Swanson, Bonneville Power Administration; W. J. Olson, Seattle City Department of Lighting; W. J. Mosley, Puget Sound Power and Light Co.; and Maurice Hatch, Washington Water Power Co.

An additional session of the Power Division was arranged for Thursday afternoon, when Henry L. Gray, Seattle consulting engineer, presented a paper on "Some Aspects of Public Utility Condemnation Cases." This paper constituted a report to the Division of its Subcommittee on the Valuation of Power Plants and Properties," of which Mr. Gray is chairman. The report analyzed condemnation proceedings in the State of Washington, where special legislation regulating public acquisition of utilities has been in effect since 1931.

R. Wayne Lincoln

Ultimate economical development of up to 27,000,000 kw of hydroelectric power in the Columbia River Basin, with annual benefits exceeding $400,000,000, was portrayed as a possibility by Mr. Lincoln. He said that while "an estimate of the income of allied industries made possible by this energy is outside the scope of this paper, it is safe to say that power generation will be one of the greatest industries of the Pacific Northwest."

"The ultimate economical development of hydroelectric prime power in the entire basin may approximate 17,000,000 kw, with a firm capability of 23,000,000 and a rated capacity of 27,000,000," Mr. Lincoln declared.

Asserting that construction of necessary reservoirs for either flood control or navigation alone "is not economically feasible and cannot be financed without power revenues," Mr. Lincoln envisioned appreciable benefits to navigation to be provided by operation of power dams.

Of the recent flood, as well as of a major inundation in 1894, he said:

"Damage from either could have been largely eliminated by proper manipulation of a major portion of the storage capacity in conjunction with a system of dikes of moderate height. For instance, only nominal damage would be sustained for a discharge of 750,000 cfs at The Dalles. In the 1894 flood the runoff over and above this capacity was less than 14,000,000 acre-ft. This could easily have been stored by reservoir operations dictated by comprehensive snow surveys."

Investigation of damsites on the upper basin in Canada has not reached the finished stage of such investigations in the United States, Mr. Lincoln said, adding: "There are probably 10 or 12 major sites that might develop a total of 2,000,000 kw of prime power with a combined usable storage of approximately 25,000,000 acre-ft. Such large capacities may seem fantastic and far distant, but it is probably safe to say that they could be absorbed faster than they actually can be financed and constructed."

Symposium on Northwest Power Pool

Pooling of power by all major electric utilities in Washington, Oregon, Utah, Montana and Idaho, begun as a war emergency measure, is being continued in peacetime with resultant saving of $100,000,000 in reduced investment costs and increased reliability and improved quality of service, the speakers explained.

Salient features of the pool brought out by the symposium included the fact that one federal, two municipal and seven private utilities are merged in the pool which also is connected to the British Columbia Electric Co. in Canada and many small utilities. The voluntary joint venture is accomplishing the following purposes: Conservation of fuel, increased economy of operation, better and more reliable service, and greater load-carrying ability. Frequent meetings

and regular conferences and reports keep all concerned abreast of developments.

If the systems were isolated, Mr. Peterson said, standby reserve requirements would be 650,000 kw. Operating as a pool, the reserve systems require a reserve of 250,000 kw, and, depending on how calculated, the increased firm capacity may exceed 600,000 kw.

In his remarks introducing the symposium's theme, Mr. Peterson emphasized that requirements for the immediate future are extremely heavy on account of abnormal load growth. This growth, he said, originally attributed to the war-born industrial development, has persisted even after the war, and he indicated that study is being given to a proposal for tying the Northwest Power Pool in with California power utilities. Mr. Peterson hailed the pool as an outstanding cooperative project in which "for seven years privately owned and publicly owned utilities have worked together effectively and profitably."

All-Day Session of Structural Division Features Pacific Coast Projects

PROPOSED ADDITIONAL crossings of San Francisco Bay, a floating tunnel across Puget Sound, a proposed loading for highway bridges, the use of high-strength concrete for Ross Dam, and wood bridges were discussed in two sessions of the Structural Division. Meeting all day Thursday, with Stewart Mitchell, Sacramento, Calif., chairman of the Division's Committee on Forces Acting on Structures, presiding, the Division heard papers on the foregoing subjects prepared, respectively, by Ralph A. Tudor, Chief Engineer, San Francisco Bay Toll Crossings Division, California Department of Public Works; Charles E. Andrew, Chief Consulting Engineer, Washington Toll Bridge Authority, Tacoma, Wash.; Prof. T. Y. Lin, University of California, Berkeley; H. F. Faulkner, Seattle, retired resident engineer on the Ross Dam project; and T. K. May, Director of Engineering Service, West Coast Lumbermen's Association, Portland, Ore.

H. F. Faulkner

Concrete mixed and poured with exceptionally careful control in the construction of Ross Dam on the Skagit River in northwestern Washington for development of hydroelectric power, produced concrete hailed by the U.S. Bureau of Reclamation as "one of the strongest pieces in any dam in the United States," Mr. Faulkner's paper brought out.

So strong did sample core tests reveal the concrete to be, Mr. Faulkner asserted, that when it came time to increase the height of the dam in order to impound a greater amount of water than was possible with the original structure, it was found that an extra hundred feet could be added without thickening the base. The dam will be 675 ft high, as compared with the present 540 ft, and will provide storage capacity of 3,400,000 acre-ft as compared with the present 1,400,000 acre-ft. The power plant for Ross Dam, key unit in a group of three, including the Gorge and Diablo plants, is planned to develop 480,000 hp, more than the other two combined.

Mr. Faulkner's paper is planned for publication in the September issue of CIVIL ENGINEERING.

Ralph A. Tudor

Simultaneous construction of two additional San Francisco Bay toll crossings can begin in 1950 and be completed in about three years, the Structural Division was told by the man in charge of fast-moving studies now under way to relieve congestion which has rendered the present bridge to Oakland inadequate after only 12 years of use.

The decision faced by the Authority, Mr. Tudor explained, is whether finances will be adequate for construction of both the parallel crossing recommended by the California Department of Public Works and the southern crossing advocated by a Congress-authorized joint Army-Navy board or, if not, which of the two crossings should be undertaken. Mr. Tudor's paper appears in this issue, page 38.

T. Y. Lin

A method of designing highway bridges more realistically, with particular relation to the live loads they must support, is needed in the face of the rapid growth in number and weight of trucks using the highways, Professor Lin asserted.

Claiming that "an increase in loading capacity together with simultaneous economy in material" would result, Professor Lin detailed his recommended design load, speaking under the auspices of the Structural Division's Committee on Forces Acting on Structures.

Calling the present design loading "neither consistent with actual conditions nor with safety and economy," Professor Lin pointed out that the subject has not been given thorough study in the past because of "the fact that, in spite of the arbitrary loadings now used in designing, practically all the bridges, with the exception of a few, have withstood the unexpected service." That the problem is a complicated one is plain, he said, "when we realize that stresses in bridges are not only affected by the weights of all the axles, but also by the spacings between them, by the combination of different vehicles on different span lengths, the coexistence of other forces, and sometimes the probability of occurrence."

In outlining his method of arriving at a proper loading, Professor Lin emphasized that the ideal design load is one which will represent the maximum effects of actual vehicles. He further explained that the logical design stresses should also be those which actually exist in the bridges.

Charles E. Andrew

A floating steel and concrete tunnel nearly three miles long, to carry four lanes of vehicular traffic, estimated at 10,000,000 cars annually, was envisioned by Mr. Andrew as "the only type of structure possible" to link Seattle with the 5,400 square miles on the Olympic Peninsula across Puget Sound.

An expenditure of 50 to 55 million dollars for this solution would be fully justified by the time saved for those now using slow and costly ferries and by the resulting future development and property values that would accrue, he said.

Upward lift of the tube, the top of which would be 50 ft below the water's surface, would be resisted by live-load anchors weighing 500 to 600 tons each and resting on soft bottom material in water depths as great as 800 ft, Mr. Andrew declared. The anchorage principle, he said, "simulates the sole fish which can lie on the bottom for long periods in swift tides with no appreciable scour occurring." He described construction methods contemplated, detailing how water would be admitted into the sections to sink them to the desired depths, and told of the 30,000-ton floating fenders to

be used in guarding against ships' colliding with the ventilating towers called for in the project.

Water depths of from 600 to 800 ft at various crossing sites considered, wind velocities of up to 80 mph, and transit requirements of shipping were listed by Mr. Andrew as reasons why the unprecedentedly large floating tunnel constitutes "the only type of crossing which can be devised to meet the physical conditions." Preliminary cost estimates vary from $45,000,000 to $65,000,000, he said, depending on prices and conditions which may exist in the future.

Waterways Division Hears Papers on Port Developments and Wave Forecasting

WAVE FORCES which the waterfront structures civil engineers design must be able to withstand, may be ascertained through the use of wave recorders which have been in operation for almost a year, it was brought out in one of three papers which featured the Waterways Division session at which Robert W. Abbett, New York, chairman of the Division's Committee on Ports and Harbors, presided.

This paper, "Recent Contributions of Wave Research to Airport Engineering," was prepared by Prof. J. W. Johnson, University of California, Berkeley, Calif. Other papers were prepared by G. T. Treadwell, chief engineer, Port of Seattle, on "The Development of the Port of Seattle," and R. R. Shoemaker, chief engineer, Harbor Department, City of Long Beach, Calif., who read his own paper on "Facilities at the Port of Long Beach."

J. W. Johnson

Describing the wave recorders operated by the University of California in cooperation with the Navy, Professor Johnson's paper described wave recorders which have been in operation for almost a year at Point Sur, Calif., and Heceta Head, Ore.; two installations which recently were made at Point Arguello and Point Cabrillo, Calif.; and a fifth installation now being planned for the Washington coast.

"These recorders will provide sufficient coverage of the Pacific Coast to permit a compilation of statistical data on wave conditions at selected points along the coast," Professor Johnson declared. "Wave data for intermediate localities can be estimated by interpolation. Data from the wave records also provide a means of checking the method of forecasting waves from weather charts.

"All the various recorders which have been developed by the University of California work on the principle of recording pressure fluctuations at the sea bottom and transposing these values to surface wave heights. The fundamental principle of the method is that surface waves induce pressure fluctuations in the entire column of water between the surface and the sea bottom. For a particular depth of water and wave height, the amplitude of these fluctuations depends on the wave period."

Stressing the value to the designing engineer of information thus obtained, Professor Johnson asserted:

"Not only does it give the wave characteristics which structures must be designed to withstand, but it also permits an investigation to be made as to whether structures are economically justified in view of the frequency of occurrence of waves of a damaging character."

G. T. Treadwell

How the Port of Seattle, despite its location 125 nautical miles distant from the Pacific Ocean, has grown from a minor lumber loading center to one of America's major gateways for the future development of which an expenditure of $20 million is contemplated, was detailed by Mr. Treadwell. He stressed the "natural and fundamental economic and social causes" underlying the growth, saying:

"These forces still prevail and we must recognize them if we are to fulfill our destiny in the future development of the Seattle area. This is both our duty and our responsibility."

Manufacturing, industry and population in Seattle show steady increases year after year, with the result that Seattle, nearest United States port to the Orient and gateway to Alaska, ranks eighth in commerce of U.S. ports, Mr. Treadwell declared.

"During the war emergency," he said, "several terminal units formerly used for general commerce were taken by the Armed Forces. Two of these were the largest pier-type structures in the world. Comparative cargo, berthing and storage space made them the equivalent of ten ordinary waterfront terminals. Plans for future port improvement contemplate the expenditure of $20 million for replacement of this wharf and pier-type space by new construction, further expansion, and modernization of the older terminal facilities.

Mr. Treadwell described how the Port of Seattle grew by leaps and bounds following the discovery of gold in Alaska, development of the Panama Canal, advent of the northern route for transcontinental railroads, and opening of the Lake Washington ship canal, and had this to say of the proposed future developments:

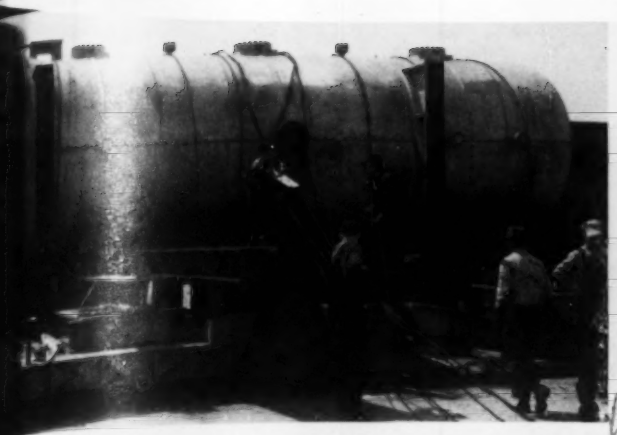
"Development of the central waterfront of the Port of Seattle has reached the planning stage. A logical type of development is a wharf constructed parallel to the shore. Preliminary studies indicate that a marginal wharf can be constructed for approximately 3,000 ft in addition to a conventional type of pier jutting out from the land. Seattle's waterfront today remains one of its greatest assets."

Robert R. Shoemaker

Need for comprehensive planning in connection with modernization and expansion of the Port of Long Beach, Calif., was stressed by Mr. Shoemaker in his paper. Emphasizing the related and planning problems, Mr. Shoemaker detailed the history of the development and said:

"If there is one lesson demonstrated by experience to that group of the civil engineering profession which devotes its efforts to port location, design, maintenance and operation, it is the great necessity for careful advance study before proceeding with development. All factors—past, present and future, economic, physical or political—which can possibly bear upon the success or failure of a new port, deserve attention before initial work is done. A penetrating analysis of all the factors and flexible comprehensive planning well into the future will always pay handsomely in errors avoided and obsolescence prevented."

Citing examples of "economic losses which can result from lack of planning," and other examples to demonstrate some of the values of planning, Mr. Shoemaker asserted that within 15 years from the date of their completion, $2 million, or two-thirds of the value of some of the port installations "must be written off as worthless, as such installations are buried in expansion and progress, and in dredged fills, and soon must be completely written off."



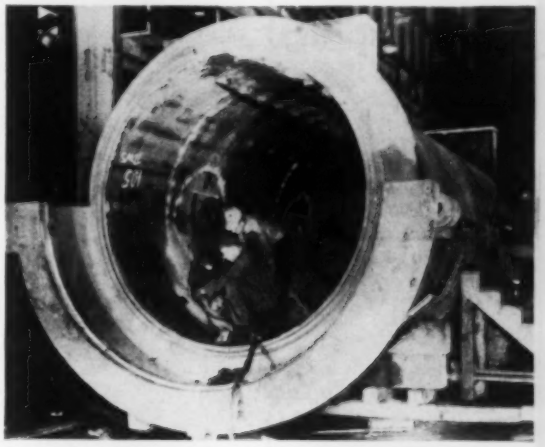
ECIAL HANDLING AND ROUTING permit transportation of giant steel pressure tank from point of manufacture by Babcock and Wilcox ., at Barberton, Ohio, to Naval Ordnance Laboratory at White Oak, Md. First lap of journey, by rail on special flatcar, with train speed ited to 25 mph, ends at Silver Spring, Md., where tank is transferred (above, left) to 40-wheel trailer. Last lap of trip (above, right) is r carefully mapped route at maximum speed of 3 mph. Permit for movement of unwieldly load is provided by Maryland State Roads ommission. Riggers and iron workers of S. & E. McCormick, Inc., construction company which furnished trailer, ride atop vehicle to check erhead cable clearances.

Transportation of 105-Ton Pressure Tank Taxes Rail and Highway Facilities

ROBLEMS INVOLVED in moving e 105-ton hydrostatic pressure tank be used for testing underwater dnance at the 15-million-dollar val Ordnance Laboratory under nstruction at White Oak, Md., re- ired close coordination of trans- rtation facilities from shop to site. operation of several governmental, nsportation, and contracting ncies made possible the transfer the tank from Barberton, Ohio, to e Mechanical Test Building at hite Oak.

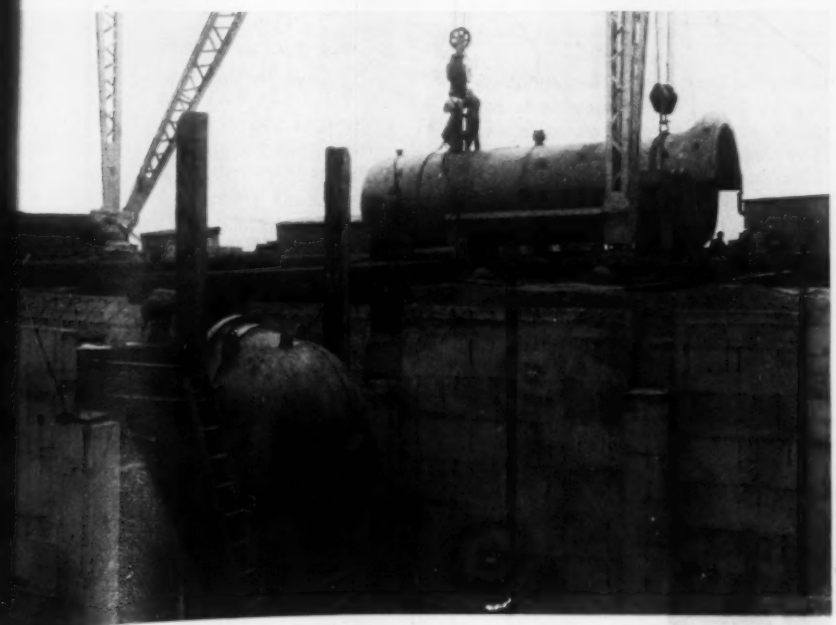
Installed on a low-bed flatcar, the nk was hauled from Barberton by e Pennsylvania Railroad via the "high-car route," a journey requiring more than four weeks. On the final leg of the trip the Baltimore & Ohio Railroad took the loaded flatcar to

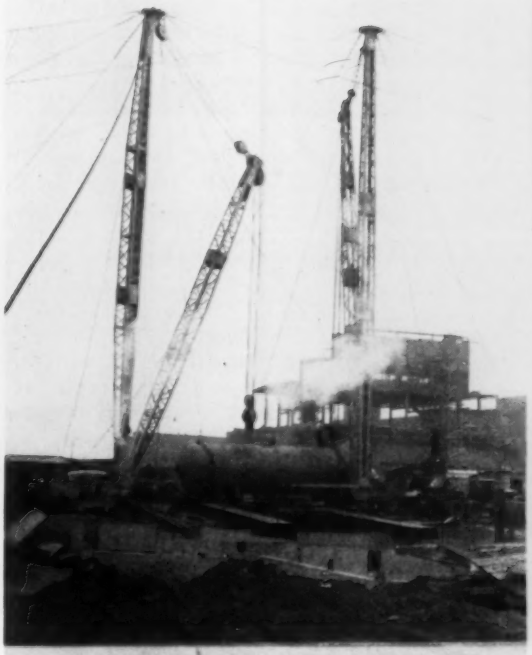
(*Continued on page 84*)

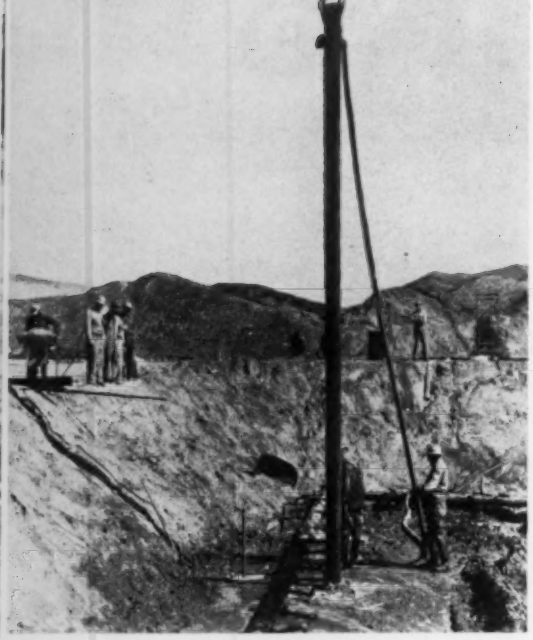


PRESSURE TANK composed of four sections welded circumferentially, with average shell thickness of 5 in., is submitted to latest metals testing procedure (right) to ensure strength of 2,000 psi, although operating pressure is expected to be about 1,000 psi. Tank is 38 ft 5 in. long, with outside diameter of 8 ft 11 7/8 in. Door, 7 ft long and weighing 40 tons, is hydraulically controlled and is sealed with pressurized gasket. Leakage from door is expected to be less than 1 cu ft of water per hour at 1,000 psi.

UNDATION FOR PRESSURE TANK (below, left) is prepared in building at site of Naval rdnance Laboratory. I-beams welded on sides of tank are fabricated to heavy steel frame. ecially constructed hoists and booms (below, right) lift tank from trailer to final position thin foundation for Mechanical Test Building.







WELL POINTS ARE JETTED into ground and connected into header at 3½-ft intervals in test area. Jetting is done by 8-in. pipe, 25 ft long, capped at top and fitted with 2½-in. hose connected to high-pressure pump.

Field Tests Indicate Best Procedure for Unwatering of Davis Dam

A. H. AYRES, M. ASCE
Chief Engineer, The Utah Construction Company, San Francisco, Calif.

DAVIS DAM, the sixth of a series of dams which agencies of the U.S. Government have built or are building for the control or use of the waters of the lower Colorado River, lies about 60 miles downriver from Hoover Dam. The 3,800,000-cu yd rolled earth and rockfill structure, being built at a cost of about $70,000,000, will provide about 1,400,000 acre-ft of regulatory storage and will utilize the drop in the river between Hoover Dam and Parker Dam for an ultimate power development of about 225,000 kva. (See CIVIL ENGINEERING, January 1947, page 14.) Reviewed herein is the well-point pumping plan developed by the contractor on the basis of tests conducted at the damsite to determine the most economical methods and equipment for unwatering the base of the dam. This paper was presented before the Construction Division at the ASCE Summer Convention in Seattle, Wash.

AT HOOVER DAM and at Parker Dam, rock was available for foundations for masonry structures, although at depths of 145 and 245 ft, respectively. At the other four sites of dams on the lower Colorado River, rock was either not available or was at such depths that its use as a foundation would be prohibitive in cost. At Davis Dam, rock of adequate quality was available at both abutments, but in the river channel was 100 to 170 ft below the river bed, a fact that doubtless influenced the designers in their choice of an earth and rockfill type of dam for this location. The spillway and power plant with its intake structure are located at the downstream end of a diversion and forebay channel excavated through a rock ridge adjacent to the left abutment of the dam, and therefore are not directly involved in the problem of unwatering the river channel, except for the tailrace section of the power plant.

The dam itself will be about 135 ft high from streambed to crest, with a cutoff trench of 120-ft bottom width extending 65 ft into the river bed. Because of the pervious nature of the river-bed materials, the plans call for an upstream apron or blanket extending a distance of about 700 ft from the center line, and a downstream blanket about 600 ft in length. The base of the dam is roughly 1,300 ft square, exclusive of any areas required for upstream and downstream cofferdams.

The sequence of construction operations is such that the river cannot be diverted from its channel and the base of the dam unwatered until the following operations have been completed: (1) Excavation of the diversion channel, and the forebay and spillway channel through the high left rock abutment; (2) excavation for the spillway, intake and part of the powerhouse structures; and (3) placing of concrete in the forebay channel and in the bases of the spillway and intake structures. Thus ample time has been available to investigate the materials in the river bed and to work out adequate methods and equipment for the economical unwatering of the base of the dam.

Conditions Similar to Those at Imperial Dam

At Imperial Dam, built in 1936-1938 by the Bureau of Reclamation about 18 miles above Yuma, Ariz., the situation was much like that at Davis Dam. Rock was available at or near both abutments, but was none too good in quality. In the river bed the rock surface dipped steeply and for a distance of over 2,000 ft was more than 50 ft below the river bed. The dam, with its two sets of headworks and sluiceway, was about 3,000 ft in length and entirely of concrete. The spillway section, about 1,200 ft long, formed the central section of the dam, about on the center line of the original river channel.

The river-bed materials were silt and fine sand. At the right abutment, sufficient unwatering was usually accomplished by centrifugal pumps in sumps, with unwatered areas kept as small as reasonably possible. At the left abutment and in the river channel, unwatering was first attempted by several deep-well pumps set well below foundation level. In operating these pumps, the drawdown curve was found to be so sharp and steep that the pumps were almost ineffective. A comprehensive system of well points and self-priming centrifugal pumps was then installed. This well-point system functioned with much greater efficiency and accomplished the desired results. About 3,000 well points and 30-odd 6- and 8-in. centrifugal pumps were required. The amount of water pumped was 18,000 to 20,000 gpm maximum.

Test Run Made with Deep-Well Pumps

Conditions at Davis damsite, and results secured at the other Colorado River damsites, indicated that well points hooked up to self-priming

DAVIS DAM was advertised for bids by the Bureau of Reclamation in May 1942, and the contract was awarded to The Utah Construction Company of San Francisco. After extensive plant and equipment had been assembled and forebay channel excavation had begun at the downstream end, the contract was terminated on account of wartime equipment and material priorities. After the close of the war, the lifting of priorities made it possible to continue construction, and the Bureau again advertised the work in December 1945. The Utah Construction Company was again low bidder, and was awarded the contract in January 1946.

JET CASING is filled with filter sand after well point is placed inside. Casing is then pulled, leaving well point in place.

centrifugal pumps would be the most effective unwatering arrangement. There was, however, a possibility that deep-well pumps would be more effective than at Imperial Dam, and a test run of the equipment was made.

Five deep-well casings were sunk in the soft sandy material of the river flood plain at the Arizona abutment of the dam. See Fig. 1. Those casings were about 20 ft apart, from 0 to 125 ft back from the river's edge, and immediately downstream from the toe of the upstream Arizona cofferdam. Wells Nos. 1 and 5 were 16 in. in diameter, and wells Nos. 2, 3 and 4 were 8 in. in diameter. The wells were sunk to depths varying from 83 to 120 ft. Gravel, rather fine in character and spotty as to elevation, was encountered at depths varying from 25 to 100 ft. Wherever this gravel was encountered the casings were slotted in place with ten ¼ × 3-in. slots every 18 in. in depth from 5 ft above the bottom of the casing to 5 ft above the first gravel strata encountered.

A 12-in. pump with 78-ft shaft was set in well No. 1, and a 10-in. pump with 50-ft shaft was set in well No. 5. These pumps were operated for 74 hours for a total discharge of 5,710,000 gal of water. In the wells being pumped, drawdown was normal, and the pumps operated at about normal capacity. The drawdown in wells Nos. 2, 3 and 4 averaged 0.5 ft, 3.5 ft and 6.5 ft respectively. There was, however, little or no lowering of the water table in the river-bed material adjacent to the wells. This fact showed that the flow was being produced only from the deeper gravels, with little or no dewatering of the shallower sands near the river-bed level. This conclusion was somewhat confirmed by temperature readings of the water from the river and pump discharges, which showed 53 and 84 deg F, respectively, with no change during pumping.

A third 6-in. pump was then installed in well No. 3. Relative water temperatures remained the same, and the small drawdown in wells Nos. 2 and 4 was unchanged, showing that the area of effect of a deep-well pump in the material near the surface was very small, and that only the deep, heavy underground flow was being drawn on, without any material effect on the shallow strata in which the major part of the dam cutoff excavation was to be carried on. Although the results showed some similarity to those obtained from deep-well pumps at Imperial Dam, they differed markedly in one respect: at Imperial the deep-well pumps pulled out the water from a small area of sand and silt and then ran dry, but in the Davis experiment the water level in the upper sand strata was drawn down in a very small area only, and the coarser, deep substrata furnished a continuous supply of water with no effect on the upper strata.

These tests showed that deep-well pumps would have little effect on the major part of the river-bed material, unless spaced so closely as to be prohibitive in cost. The tests also indicated that the upper strata of river-bed material were pervious to a certain degree, and that well points might be effective. The area involved in the unwatering was so extensive, and the well-point equipment that might be required would represent such a large investment and operating expense, that it seemed best to secure more positive experimental results before taking final action.

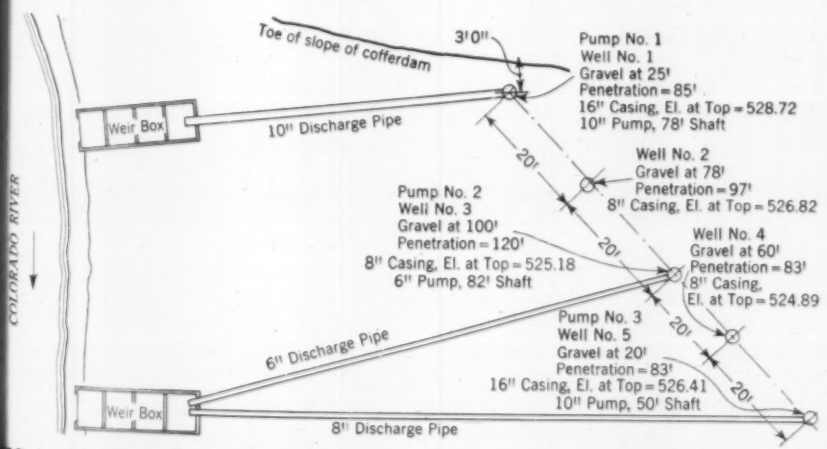


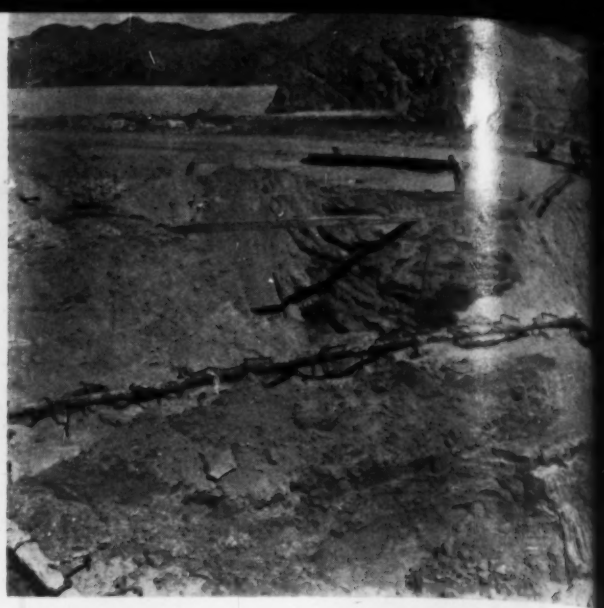
FIG. 1. FIVE DEEP-WELL CASINGS, sunk to depths varying from 83 to 120 ft into soft sandy material on Arizona side of river, have little or no effect in dewatering shallower sands near river-bed level. Each well casing has ten ¼ x 3-in. slots spaced 18 in. apart and extending 5 ft above and 5 ft below gravel.

Full-Scale Test Site Selected

It was therefore decided to make a full-scale test in a small area where subsurface materials and water conditions would be as nearly as possible the same as in the river bed. A location for the test was selected on the Nevada side of the river, a short distance above the downstream end of the river section to be unwatered, and about 180 ft back from the river's edge. Here an area about 50 × 70 ft was cleared and leveled to El. 518.3, about the same as the average water level in the river. Within this area, 200 ft of 8-in. pipe header was installed in rectangular form 45 × 58 ft and connected to two 8-in. centrifugal pumps with vacuum control units. The pumps were connected to discharge lines leading to the river, and were fitted with the necessary gate valves so that either one or both pumps could be operated.

A total of 66 well points, each connected to a 2½-in. pipe riser 21 ft long, were jetted into the ground along the line of the header, and connected into it at an average interval of 3½ ft. Jetting was done by means of an 8-in. pipe 25 ft in length capped at the top, heavily serrated at the bottom, and fitted at the top with a 2½-in. hose connected to a high-pressure 4-in. centrifugal pump. This jet pipe was handled by a bale at the top, and lowered and raised by a line from a crane on the bank. When the 8-in. pipe reached bottom, the cap was removed, the well point and pipe were inserted, the annular space around the well-point pipe was filled with

FULL-SCALE TEST is made in 50x70-ft area on Nevada side of Colorado, close to section to be unwatered. About 200 ft of 8-in. pipe header, installed to form rectangle, is connected to two 8-in. centrifugal pumps.



AFTER DEWATERING, material within rectangle is excavated to drained depth of 16 ft to determine condition of river-bed material. Material disclosed is 12 ft of clay-sand, 1 ft of free-draining sand and then another layer of clay-sand.

coarse sand and fine gravel, and the 8-in. pipe slowly removed. Thus, the well point and its riser pipe were surrounded and protected from clogging by a filter which prevented the entrance of fine sand and silt. The well-point pipes were then connected to nipples on the 8-in. header by a double elbow, valve and union connection, which could be disconnected or connected as needed, without disturbing other well-point pipes.

After the well-point pipes were all set at proper depth and connected to the header, pumping was started. Two pipe risers with well points, but without connections to the header, had been installed, one on the northwest or upstream land side of the test rectangle, and a second at the southeast corner of the rectangle. Later two other well points were disconnected from the header and used as test wells, one at the center of the north side of the rectangle, and the other at the south end of the west side. Temperatures of river water and pump discharge water were recorded during the test run.

Single Pump Handles Test Run

The first test run was 172 hours in length. The amount of water pumped was 8,386,548 gal from 63 well points. This is an average output of 812.65 gpm, or 13 gpm per well point. One pump with a vacuum of 25 in. provided all the required pumping capacity. The maximum rate of pumping was 1,040 gpm. At the end of 25 hours, subsurface water at pipe No. 1 was at El. 505.2, about 13 ft below the ground surface within the rectangle, and about the same distance below the river surface. Water-surface elevations at pipes Nos. 3 and 4 were about 2 ft and 3 ft lower respectively, showing the effect resulting from the closeness of pipe No. 1 to the river.

The minimum elevation reached in the pipes during the test run was 503.4 in pipe No. 1, and 500.9 in pipe No. 4. These elevations were somewhat affected by a lowering of the water surface in the river to 515.6. The best differential elevation secured was 14.4 ft and 17.4 ft, respectively, about halfway through the test run. River-water temperature was between 52 and 54 deg F during the run, while the pump discharge temperature remained steady at 74 deg F. The latter fact is enlightening in comparison with the tests on deep-well pumps which thus proved to be pulling almost entirely from lower strata, as evidenced by the 10-deg F differential in water temperature.

It was desirable to find out the condition of the river-bed material as it would be excavated, so the material within the well-point rectangle was excavated by clamshell beginning about a week after dewatering was started. Water was reached in the excavation at El. 502.2 or at a drained depth of 16 ft. Material disclosed was 12 ft of clay-sand, 1 ft of free-draining sand, then 3 ft of clay-sand again. Sieve analysis of the average material showed an effective grain size of 0.20 mm; i.e., 20 percent of the material is smaller than 0.20 mm in diameter, and 80 percent of it is larger than 0.20 mm. Therefore a roughly approximate value for coefficient k (of permeability) is 0.0175 in the Darcy formula. The material stood up on slopes of 1 horizontal to 4 vertical with little or no tendency to slough, showing fairly good drainage characteristics.

Excavating was also done outside of and north of the area with a dragline bucket. Water was encountered at El. 505.7 or 3.5 ft above the water within the rectangle at a distance of about 10 ft from the well-point line, thus showing a fairly sharp drawdown curve. The pump was then partly shut off, and the excavated area allowed to fill to the same elevation as that of the river. A second pumping test was started two days later. This time unwatering to El. 504 was accomplished by one pump in about 18 hours, indicating that, after initial unwatering, the pumping load could be expected to hold about the same as during the dewatering stage in order to maintain the lowered level inside the well points.

Tests Furnish Data Needed

These tests, while providing some measure of information as to the capacity that could be secured per well point, showed that it would be necessary to provide continuous pumping from lines of well points extending completely across the river bed both below and above the area to be unwatered; that additional lines of well points would be required for approximately each 16 ft of depth of excavation; and that deep-well pump installations would not be effective for unwatering unless spaced so closely as to be prohibitive in cost and even then might not provide an effective curtain against shallow horizontal flow. The deep-well pump tests did, however, emphasize the probable occurrence and extent of an underflow in the deeper part of the river channel which, while partly below the elevation of the bottom of the cutoff trench, would bring into close proximity to the unwatered areas a considerable reservoir of water against which the well-point lines would often need to be doubly effective. It therefore behooved the contractor to have

ample installation of well points, even though at most times the higher-level tiers would not be fully used. The first operation in the unwatering of the river bed is the turning of the river into the diversion channel and through the forebay channel and partly completed spillway structures on the east or Arizona side of the river. Two timber and pile trestles have been constructed across the river, one at the upper edge of the upper cofferdam, and the other immediately below the powerhouse tailrace, but above the outlet of the spillway. The upper bridge has two continuous longitudinal openings in the deck, one in each of the two truck lanes, through which bottom-dump trucks will dump rock from two nearby quarries one on each side of the river. The lower bridge will be used to dump finer muck from its lower side after upstream closure has taken place, and can also serve as a framework for the support of a timber cofferdam wall backed by earthfill. These two trestles are about 2,100 ft apart along the axis of the stream bed. Between the cofferdams a river-bed area of 2,000 × 600 ft will have to be pumped out. Initial unwatering will be accomplished by horizontal centrifugal pumps (on skids or barges) connected to pipes discharging over either the upper or the lower cofferdam.

Location of Well-Point Lines

The first lines of well points will be installed: (1) Immediately downstream from the inside toe of the upper cofferdam; and (2) immediately upstream from the inside toe of the lower cofferdam. See Fig. 2. The upper line will be about 1,175 ft in length with 290 well points spaced an average distance of about 4 ft apart. Hooked to the headers of this string of points will be five self-priming or vacuum centrifugal pumps capable of handling 1,500 to 1,600 gpm at 100-ft total head. The downstream well-point line will be about 500 ft in length along the cofferdam and 600 ft in length across the flood plain on the Nevada side of the river. It will be equipped with about 260 well points and four pumps similar to those on the upper cofferdam line. The upstream header will be set at El. 522 and the downstream header at El. 520.

As the pumping from these two lines of well points becomes effective, and the water table adjacent to them is lowered the expected amount of about 16 ft, excavation will be started within and immediately adjacent to the well-point lines to such depth as the unwatering of the ground will permit. As space is thus provided, a second set of well-point lines and headers will be placed at El. 506 at the upstream end and at El. 505 at the downstream end of the area, and hooked up to a like set of self-priming pumps. With this installation, up to about 7,500 gpm can be pumped from each of the two upstream well-point curtains, and about 6,500 gpm from each of the two downstream well-point lines. It is hardly to be expected that the full capacity of both lines of well points or both sets of pumps will be needed continuously, and probably most of the higher-level points at each end can be kept in reserve for unexpected fluctuations in the river level, or to close off flows through any particularly porous substrata. Very little lateral flow into the cofferdam area is anticipated from the canyon sides, which are almost entirely of rock, and apparently without springs of any size.

WELL POINT is shown in bottom of excavation in unwatered test area. Bottom of hole is about 1 ft above top of well point proper. Filter sand about well point is seen in view.

The average elevation of the river-bed area at the damsite is El. 520. The entire area of the base of the dam will be stripped to about El. 510. The upsteam curtain of well points will be effective to El. 490, and should maintain the dam base in a satisfactory condition to the required base elevation even

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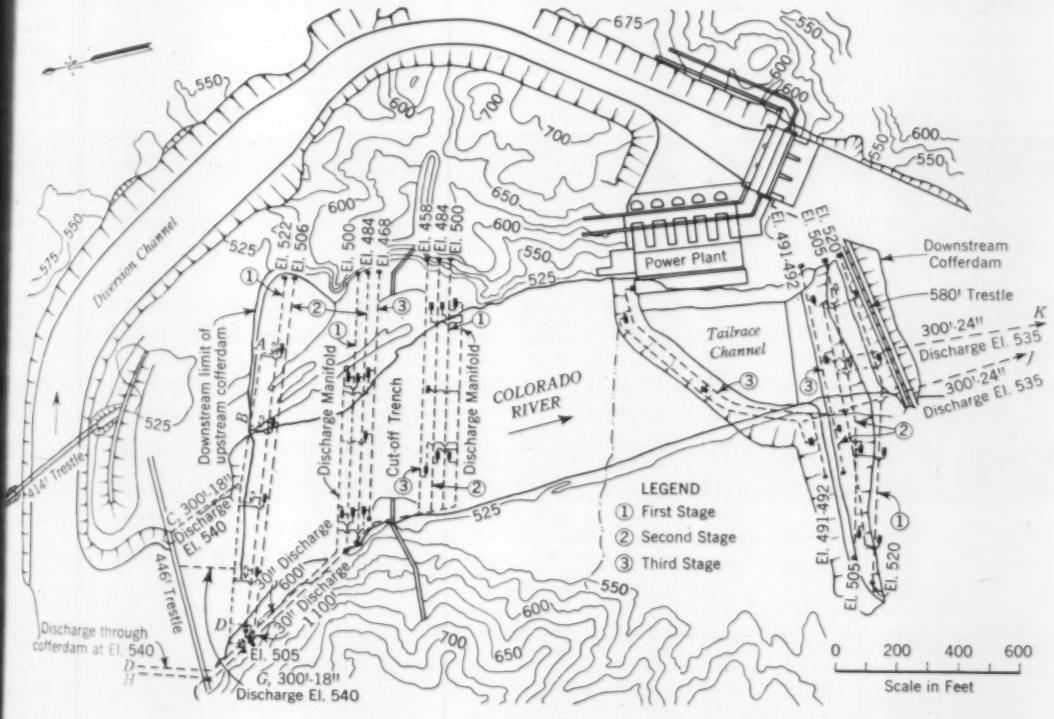
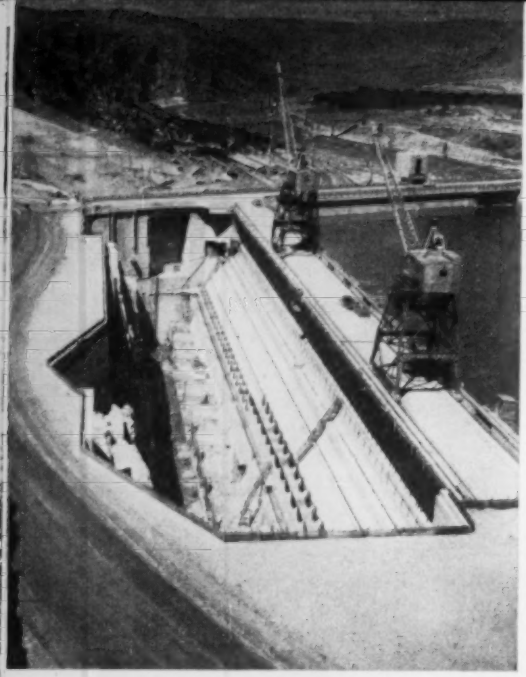


FIG. 2. LAYOUT of well-point system shows over-all plan for development of damsite. Rock is available at abutment of dam but in river channel is 100 to 170 ft below river bed. Cutoff trench, 120 ft wide at bottom, will extend 65 ft into bed of river.



FOUNDATION FOR WORLD'S LARGEST PUMPING PLANT is under construction between highway retaining wall at left and Pumping Plant Wing Dam adjacent to Grand Coulee Dam at right. Pumping plant will have twelve single-stage pumps with rated capacity of 1,350 cfs at 310-ft head. Each pump will be powered by a 65,000-hp motor.

Projected Construction Program Develops Columbia River Basin for Irrigation

L. V. DOWNS, Assoc. M. ASCE

Construction Engineer, U. S. Bureau of Reclamation, Coulee Dam, Washington

DEVELOPMENT of the Columbia River Basin for irrigation of over a million acres of fertile land in central Washington actually started when ground was broken for the Grand Coulee Dam and power plants December 13, 1933. During the past 15 construction seasons, work has continued with varying intensity and emphasis toward the ultimate goal of delivering 3,920,000 acre-ft of water annually to semi-arid but irrigable lands, and in developing at Grand Coulee power plants hydroelectric facilities with an ultimate actual capacity of 2,300,000 kw. Principal features included in the present construction and development program, with records of project expenditures, were presented by the author before the Construction Division at the ASCE Annual Convention in Seattle. This article is based on the information presented by Mr. Downs at that time.

IN POINT OF PHYSICAL accomplishment and use of labor the halfway mark in construction for the development of the Columbia Basin Project has just been passed. However, because of rising costs of materials and labor, the estimated ultimate cost of the project has increased nearly 40 percent since 1940, with the result that in expenditures of money the project was only 37 percent complete at the end of the fiscal year 1948. The magnitude of this entire undertaking may be more readily appreciated by the construction industry as a whole by reference to expenditures in money and labor. The record of the past and a program for construction through the fiscal year 1954 are shown in the figures and tables which accompany this article.

The general location and extent of the project, and the location and construction status of each of its principal features are shown in Fig. 1. The only features now structurally complete are the Grand Coulee Dam and the left power plant at the north end of the project and the Pasco pumping plant and canal system at its southern limit some 115 miles distant.

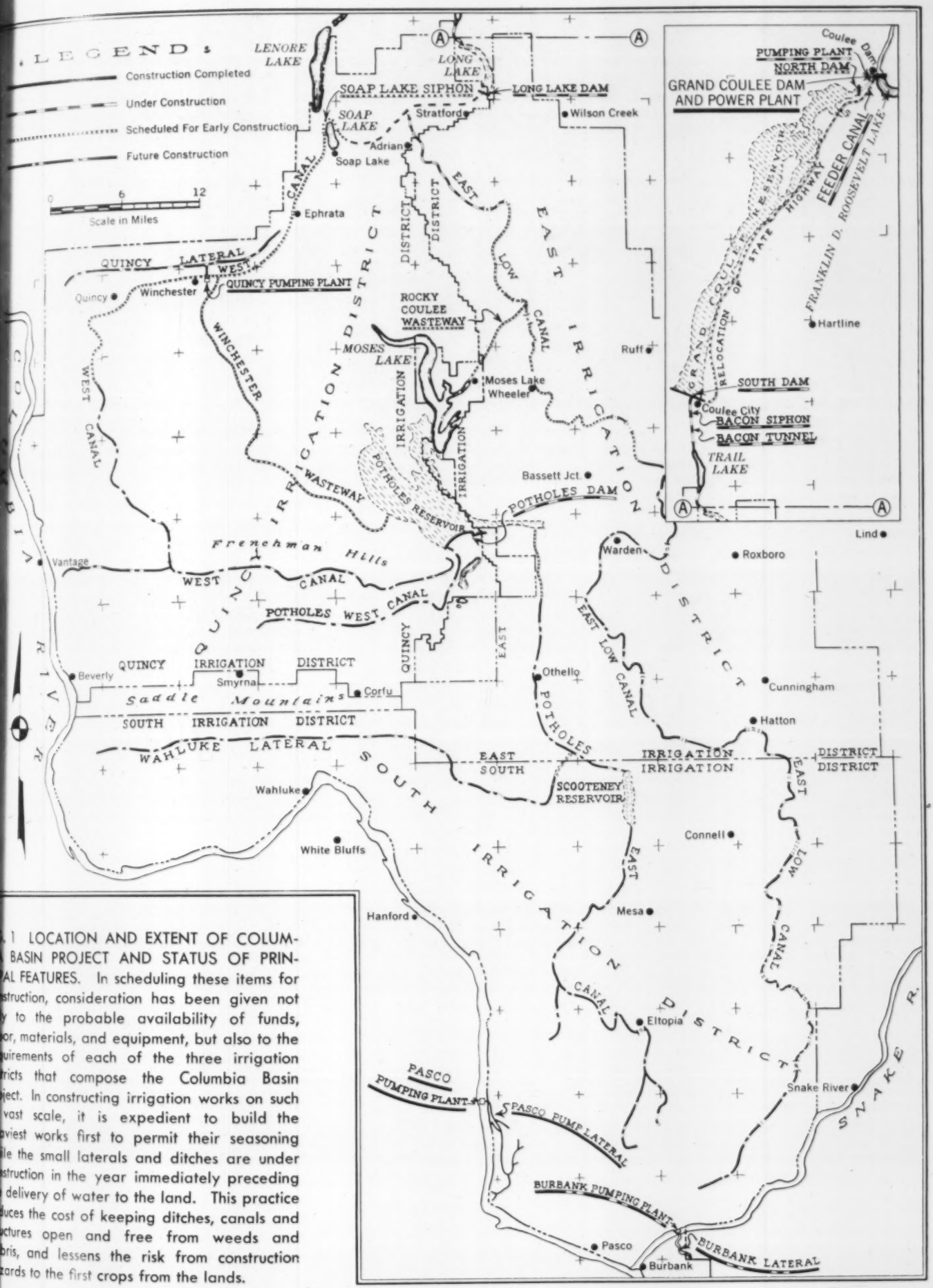
Principal irrigation features upon which construction has been started, and the estimated construction cost and percentage of completion of each at the end of the fiscal year 1948 are given in Table I. Principal irrigation features, including estimated con-

TABLE I. PRINCIPAL IRRIGATION FEATURES OF COLUMBIA BASIN PROJECT NOW UNDER CONSTRUCTION OR COMPLETED

Feature	Total Cost	Completion Date	Percentage Complete July 1948
Grand Coulee Pumping Plant:			
Initial stage (including discharge tunnel excavation)	$ 7,090,000	Aug. 3, 1947	100
Equalizing Reservoir:			
Feeder canal (initial canal excavation)	1,150,000	July 15, 1947	100
South Dam	3,680,000	May 1949	88
Main Canal:			
Canal excavation	3,100,000	Oct. 1948	85
Bacon siphon and tunnel (initial stage)	4,517,000	March 1950	50
Long Lake Dam and reservoir	2,276,000	Jan. 1949	70
West Canal:			
Canal excavation, lining and structures to Sta. 352	4,653,000	Aug. 1949	80
East Low Canal:			
Canal excavation, lining and structures to Sta. 650	5,460,000	July 1949	45
Potholes dam and Reservoir	10,983,000	July 1949	80
Pasco Pumping Unit and Canals	2,125,000	July 1948	100

TABLE II. PRINCIPAL IRRIGATION FEATURES OF COLUMBIA BASIN PROJECT ON WHICH CONSTRUCTION IS SCHEDULED TO BEGIN PRIOR TO JULY 1, 1949

Feature	Estimated Total Cost	Estimated Completion Date
Grand Coulee Pumping Plant:		
Intermediate stage (structure)	$13,789,000	June 1950
Final stage (first 6 pumps only)	8,464,000	April 1952
Equalizing Reservoir (exclusive of lands and rights-of-way):		
Feeder canal, completion of excavation, lining and structures	4,290,000	Jan. 1951
North Dam	1,665,000	Jan. 1951
State Highway 2-F relocation	3,710,000	Jan. 1951
Main Canal:		
Canal lining and structures	3,500,000	July 1951
West Canal:		
Soap Lake siphon	10,000,000	July 1951
Canal excavation, lining and structures:		
Sta. 352 to 1,229	8,740,000	July 1951
Sta. 1,229 to 2,080	1,450,000	July 1951
Winchester wasteway (first section)	2,000,000	July 1951
East Low Canal:		
Canal excavation, lining and structures:		
Sta. 650 to 1,410	9,900,000	July 1951
Sta. 1,410 to 2,200	1,800,000	July 1951
Rocky Coulee wasteway	2,000,000	July 1951
Potholes East Canal:		
Canal excavation, lining and structures, Sta. 28 to 376	4,500,000	July 1951



1 LOCATION AND EXTENT OF COLUMBIA BASIN PROJECT AND STATUS OF PRINCIPAL FEATURES. In scheduling these items for construction, consideration has been given not only to the probable availability of funds, labor, materials, and equipment, but also to the requirements of each of the three irrigation districts that compose the Columbia Basin project. In constructing irrigation works on such a vast scale, it is expedient to build the heaviest works first to permit their seasoning while the small laterals and ditches are under construction in the year immediately preceding the delivery of water to the land. This practice reduces the cost of keeping ditches, canals and structures open and free from weeds and debris, and lessens the risk from construction hazards to the first crops from the lands.

COMPLETED FACILITIES IN VICINITY OF GRAND COULEE DAM are shown in artist's conception of unfinished projects which include: Pumping plant, discharge pipes, feeder canal and headworks, North Dam and balancing reservoir, machine shop, warehouses and pumping-plant bus runway on downstream face of dam.

struction costs and completion dates for which construction is scheduled at an early date (prior to July 1, 1949) are given in Table II.

Past and predicted schedules relating to power generation and pump installations at Grand Coulee Dam, and the proposed schedule through the fiscal year 1954 for delivery of water to the 1,608 sq miles of irrigable lands on the project, are shown in Fig. 2. Present plants contemplate the delivery of water from Lake Roosevelt on the first large block of land in 1952, when 337.5 sq miles (216,000 acres) of new raw lands are expected to be brought under cultivation. Water was first delivered by pumping directly from the Columbia River near Pasco to project lands on May 15, 1948, when the Pasco unit serving 5,550 irrigable acres was placed in service.

The record of project expenditures for construction by fiscal years, and cumulative to date, is shown in Fig. 3. Estimated expenditures required to continue project construction through the fiscal year 1954 are also shown. In this presentation, which has been prepared to show the magnitude of the works upon which irrigation depends, joint (power and irrigation) facilities have been combined with strictly irrigation facilities as distinguished from facilities solely for the production of power. Fully 85 percent of the expenditures to date represent facility requirements for irrigation construction since six of the generators now installed in the left (west) power plant will be required for the seasonal pumping of water for project lands. However, these units will be used for commercial power production throughout the winter periods when peak demands throughout the Northwest Power Pool are at a maximum.

The war's end in 1945 was the signal for a broad program of construction of irrigation works throughout the project. Because of the limited working space at Grand Coulee Dam, and in order to make fuller use of construction personnel engaged in installation work and in equipment maintenance of the dam and power plants, it was planned to perform the work at Coulee Dam by forces employed by the Bureau of Reclamation. All other works were scheduled to be constructed by contract in accordance with the traditional policy of the Bureau. One year ago Congress directed the suspension of major construction work by the Bureau's own forces, and the Bureau is now preparing to contract the remaining construction at the dam.

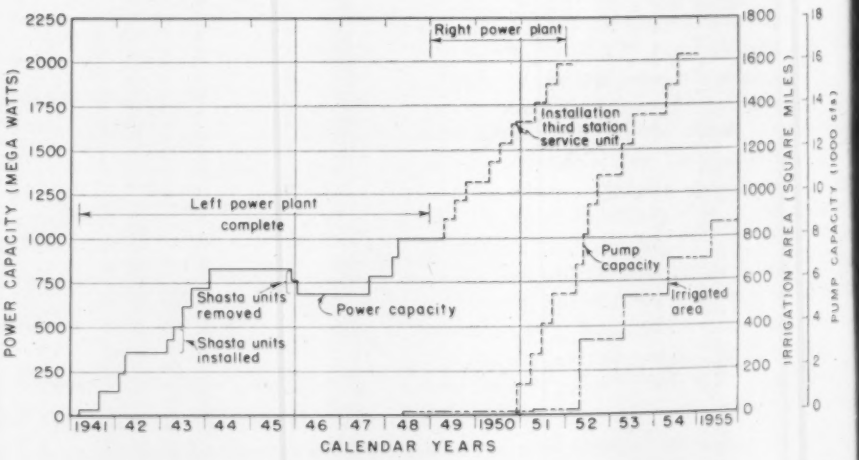


FIG. 2. SEQUENCE OF POWER and pump capacity as related to irrigation of lands in Columbia Basin Project is shown chronologically. Power capacity curve reflects installation and removal of two 75,000-kva units borrowed from Shasta Dam and Power Plant during war.

Pumping Plant Is Key Structure

Aside from the Grand Coulee Dam and power plants, the Grand Coulee pumping plant is the key structure in the entire irrigation development. Here water drawn from the reservoir above the dam will be lifted by gigantic pumps through 12-ft-dia steel pipes into the feeder canal, from which the water will flow by gravity to the farthest reaches of the project. Excavation of the discharge tunnels and construction of the wing dam, or pumping plant base, were included in the contract for completion of Grand Coulee Dam. This work was performed in 1938, 1939, and 1940, prior to the filling of the reservoir.

Completion of the pumping plant structure is included in specifications upon which bids are to be received in September 1948. The building is very similar in arrangement to the Grand Coulee powerhouses except that it is located hard against the granite abutment and therefore will not have the outward appearance of a primary structure.

The contract will also include the installation of steel pump discharge pipes, 85 percent of which are already on hand at the site. This work entails the installation and field welding of girth joints in 9,600 ft of pipe having a total weight of 5,600 tons. Embedment of these pipes in the tunnel sections will require 52,000 cu yd

of concrete. The upper half of the pipes beyond the tunnel sections will be exposed above ground.

Feeder Canal and North Dam

Excavation and embankment construction through earth, shale, granite, and basalt encountered in the 12¼-mile feeder canal were started in January 1946 and continued for 18 months. Sliding ground in heavy cuts added to the volume of the materials to be moved and, since movement continued, required a change in design to a covered section. This feeder canal, which discharges into the equalizing reservoir, has a designed capacity of 16,000 cfs. Although located through rugged terrain, the work to date has shaped the job so that it is readily accessible for completion. Contracts for the completion of the canal excavation, and the lining and structures related to it, are scheduled for bid invitation in September 1948.

Best use of the materials available from canal excavation and a better-balanced work schedule were assured by including construction of the North Dam for the equalizing reservoir with the specifications for the feeder canal. This dam will be 1,400 ft long and 130 ft high above the cutoff trench, and will contain a total of 1,120,000 cu yd of embankment materials. Work on these features is expected to get under way in early 1949, as soon as the season permits.

Equalizing Reservoir and South Dam

Within the equalizing reservoir in the Grand Coulee, only one item of major construction is required. This is the relocation of State Highway 2-F, which now runs in the bottom of the coulee. Moving this highway above the high water line in the reservoir involves approximately 1,000,000 cu yd of rock excavation and 2,450,000 cu yd of earth and talus excavation and borrow in the 30 miles of location. Some of the construction is extremely heavy, and in one 2-mile stretch rock cuts will approximate 80 ft in depth at the cliff walls, where corresponding fills are nearly 150 ft high. The raising of the road to the top of the wall was desirable at this point to avoid construction of deep fills on unstable saturated silts in the old lake bed.

When completed, this road will provide another scenic inland attraction as well as reestablishing a means of delivering the heavy turbine, pump, generator, and motor parts to the dam.

During the past two years a proud array of contractors have been assembled on the project, adequately staffed and well equipped to accomplish the work at hand. Because of the shortage of materials and supplies immediately following the end of hostilities, specifications were drawn primarily for earthworks to utilize heavy excavation equipment readily available from many wartime activities. Contractors were soon at work on the excavation of the main canal and the construction of the South Dam.

EXCAVATION FOR CUTOFF WALL, sections of completed wall and fill are seen in construction view of Long Lake Dam. Earth and rock fill embankment, about 1,900 ft long and 163 ft (maximum) high, extends across south end of Long Lake Coulee.

Adjoining Coulee City on the west, the South Dam extends 10,000 ft across the valley to form the downstream barrier of the equalizing reservoir. Work on the dam was started in August 1946, with the stripping of all unusable materials from the damsite and borrow pits. When satisfactory foundation rock was reached, a cutoff trench was excavated into the rock and backfilled with concrete in which were embedded pipes for pressure grouting operations. Sealing of the foundation rock at this damsite by grouting was of special importance to avoid loss of water due to seepage under the dam.

As the grouting operations permitted, the concrete core wall was constructed to a maximum height of 10 ft, rapidly followed by placing of embankments. Impervious materials form the central core of the dam, flanked on both faces by selected semipervious materials, with both the upstream and downstream faces covered with pervious layers of rock. Selected rock from foundation, canal, and approach channel excavations was used as riprap on the water face. When completed the South Dam will contain approximately 1,600,000 cu yd of earth and rock, and 20,000 cu yd of concrete, and will be 110 ft above the deepest point in the excavation. This work is scheduled to be completed in May 1949.

Long Lake Dam of Earth and Rock Fill

A major structure in the main canal system is Long Lake Dam, an earth and rock fill embankment extending across the south end of the Long Lake Coulee. This structure will raise the water level in a series of small lakes

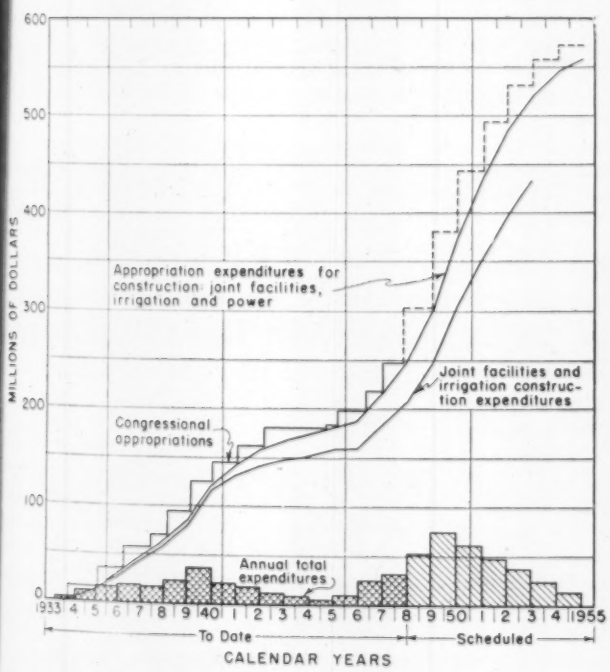


FIG. 3. MAGNITUDE OF WORKS upon which irrigation depends is indicated by graph which shows annual expenditures, cumulative total of Congressional appropriations, and cumulative total of construction expenditures for Grand Coulee Dam and Reservoir, joint facilities and irrigation facilities. Dotted lines indicate seven-year program of funds needed to complete power installations, make land purchases and bring water to 54 percent of available irrigable project land.

COMPACTED EMBANKMENT is placed adjacent to section of cutoff wall in South Coulee Dam. Completed structure will contain approximately 1,600,000 cu yd of earth and rock and 20,000 cu yd of concrete. Dam, adjoining Coulee City on west, extends 10,000 ft across valley to form downstream barrier of equalizing reservoir.

REINFORCEMENT IS PLACED as concrete work begins on section of Dry Coulee Siphon No. 1. Siphon has 25-ft inside diameter and 24-in. wall thickness.

in the gorge approximately 100 ft, and form a small reservoir within the system. This reservoir serves as a substitute for nearly 5 miles of difficult canal construction.

Excavation for this structure got under way in December 1946. The relatively shallow overburden was underlain with sound rock throughout the width of the valley. As the bedrock was exposed and loose material removed, the cutoff trench was excavated a minimum of 3 ft into the rock, and backfilled with concrete. Here, also, grout pipes were installed and the foundation was grouted as at the South Dam.

Since this dam was only 1,900 ft long, the contractor scheduled his work essentially to complete the cutoff wall construction before starting embankment operations on a major scale. After Zone 1, or the impervious embankment, was brought up to the level of the original ground surface, the entire width of the dam was carried up fairly uniformly throughout its length. Embankment materials were sufficiently close to the work to permit such a procedure with a minimum of equipment, and without objectionable delays due to moving between borrow sites.

The construction program now indicates that the dam will be completed in November 1948. When finished, the structure will be 163 ft high above lowest bedrock, and will contain approximately 1,450,000 cu yd of earth and rock in embankments.

At the center of the project development, in a semi-arid uncultivated basin, lies another of the major structures of the project, Potholes Dam, named for certain geological characteristics of the barren, untillable lands in the area. (See box, below.) This large earth and rock fill storage dam has a length of 19,000 ft, a maximum height of 225 ft, and a total volume of over 9,000,000 cu yd of embankment material.

Although at the Long Lake and South Dams surface water was insignificant and all seepage could be readily handled by pumping, at the Potholes Dam the contractor was faced with a minor diversion problem throughout the construction period. Water users along Crab Creek, below the damsite, had certain water rights, requiring a small flow of water at all times.

The diversion problem was solved by the construction above the creek bed of temporary channels and flumes to divert the flow across the damsite while removal of overburden, foundation grouting, and embankment construction to the original bed level progressed.

Water was then diverted across the top of that part of the dam while the outlet-works tunnel was being constructed. Upon completion of the tunnel, a final diversion channel, and flumes as required, will be provided to pass the water through the tunnel until the lowest section of the dam has been completed to an elevation above the outlet works.

A BILL to change the name of Potholes Dam in the Columbia Basin Project to O'Sullivan Dam was approved by President Truman on June 29. The dam was renamed in honor of James O'Sullivan, one of the original promoters.

Because of the extreme length of the dam and the location of borrow pits at each end, the contractors' excavation and embankment activities were widespread, covering a narrow strip of land more than 5 miles in length. As a rule, the overburden was shallow; but in the old creek bed the excavation extended to a depth of 84 ft before bedrock was reached.

Construction of Potholes Dam is primarily a problem in transportation and distribution, on account of the volume and length of the structure. To transport the excavated materials, the contractor assembled a huge fleet of trucks, most of them being of the large bottom-dump type but a substantial number being of conventional end-dump design.

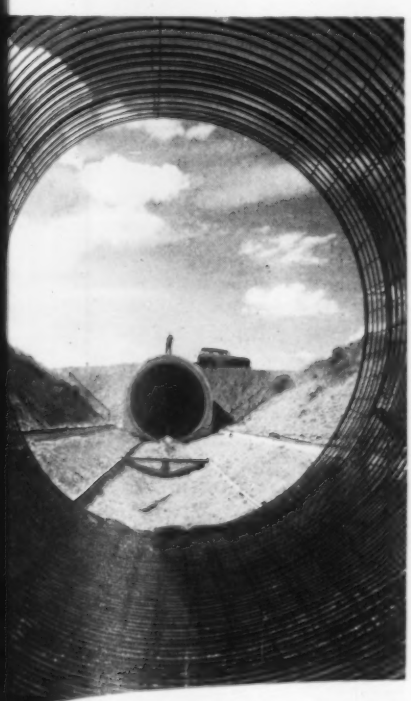
Embankment construction on the dam was started on March 26, 1947, and has progressed at such a gratifying rate that at the end of the fiscal year 1948 embankment construction was 80 percent complete. At this dam, embankment construction was facilitated by the elimination of the customary concrete cutoff wall. The embankment consists of the customary three zones or classes of material: A wide impervious zone at the center, a relatively narrow semipervious zone on each side, and substantial pervious embankments of selected sand and gravel covering both faces of the dam. Also, both upstream and downstream faces of the dam are covered with rock surfacing or riprap, half of which must be obtained in borrow in order to obtain rock of adequate quality and quantity.

The main canal below the South Dam, which is designed for a flow of 13,200 cfs, is located in rather inhospitable terrain across great basalt flows, and involves the heaviest and toughest construction work to be encountered on the entire project. In open cut, excavation extended to a maximum depth of 95 ft in solid rock. Here equipment of the heaviest type was used, with dragline buckets up to a maximum of 15-cu yd capacity.

Drilling and blasting of the deepest rock cuts required as many as three passes over the same alignment before the final depth was reached. Drilling was slow, because of the hardness of the rock and the presence of interflow zones, and the contractor spaced the holes at the greatest practical limit and loaded them with heavy charges after adequately enlarging the bores by chambering or springing. The canal emerges from the solid basalt formation below Long Lake Dam, and at the entrance to the Quincy Basin crosses great deposits of basalt gravels, the product of the glacial torrents' excavation, by erosion, of the Grand Coulee and other basalt formations to the north.

Where the canal alignment crosses above the bed of the many deep ravines or coulees, as these old, dry, glacial streambeds of the Northwest are called, it is impractical to construct open ditches. Here pressure conduits or inverted siphons of reinforced concrete are being constructed. The first of these major structures along the canal is the Bacon Siphon, ultimately to consist of two barrels, but initially consisting of a single barrel 23.25 ft in diameter and 1,013 ft in length, designed for a maximum head of 82 ft.

CRAB CREEK SIPHON NO. 1 on East Low Canal—completed section of which is seen in background—has 19-ft 4-in. inside diameter. Reinforcing bars in foreground are placed for further construction of alternate sections of 3,355-ft-long conduit.



BACON TUNNEL, which extends 10,045 ft through solid basalt rock, is being driven from both headings. Pilot bore will hole through from outlet portal to full section from north portal pictured here. Concrete-lined horseshoe conduit will have 23.25-ft maximum dimension.

Across the Bacon Coulee, the rock outcrop rises to such a height that open-cut operations were not feasible and tunneling was required. The Bacon Tunnel, which extends for 10,045 ft through solid rock, is being excavated to a horseshoe section approximately 26 ft wide and high, but will be lined with concrete to provide a horseshoe conduit 23.25 ft in maximum dimensions. The contractor is driving the tunnel from both headings and is expected to hole through with a pilot bore from the outlet portal and the full section from the north portal on August 15, 1948. This part of the main canal system is also being constructed in two stages. Ultimately a second tunnel of comparable dimensions will be driven 200 ft to the left, to carry water for the last half of the project lands.

To control seepage losses, to reduce the hydraulic gradient, and to simplify maintenance problems on the canal systems throughout the project, many of the canals are being or will be lined with concrete and other materials of satisfactory durability.

All work on the Columbia Basin Project is under the supervision of F. A. Banks, Assoc. M. ASCE, District Manager, U.S. Bureau of Reclamation.

Development of India's Water Resources Provides for Power and Irrigation Needs

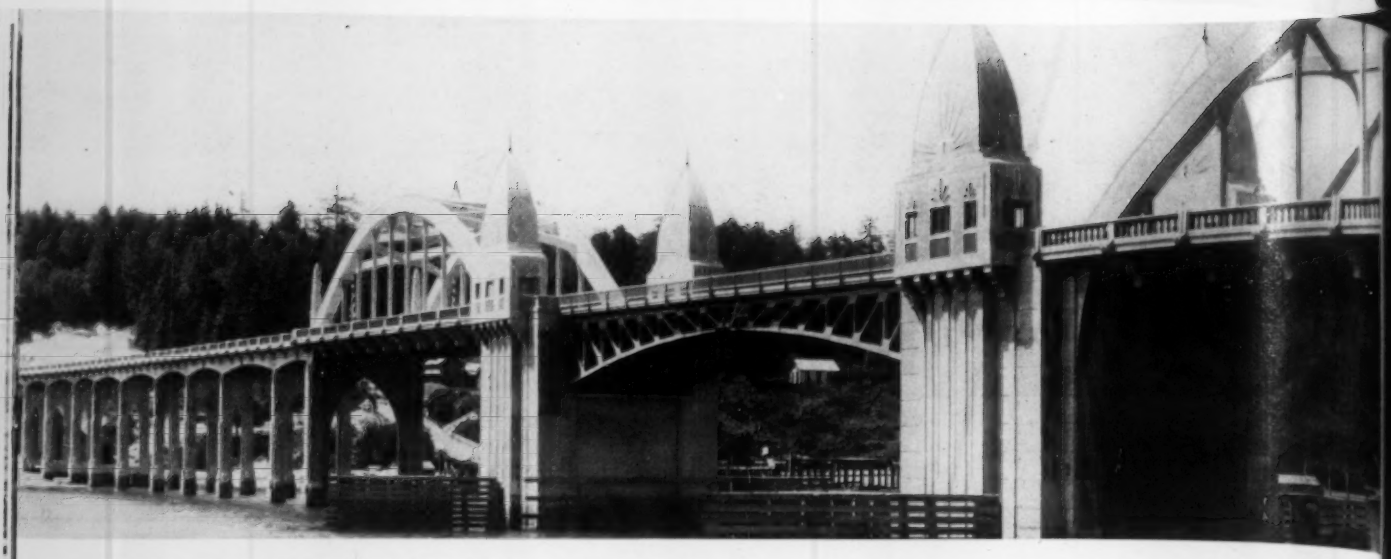
WATER IS PART of India's enormous natural wealth which, if properly exploited, might put her at the top of the power-producing countries of the world. Very little, unfortunately, has been done in the past to develop this potential energy. The new national government of India is working on a dozen or more hydroelectric schemes which will provide approximately four million kilowatts of electric energy to run numerous industrial plants now being set up or to be set up in the future, to operate pumping machinery for irrigation and drainage, and to supply water for domestic use. Additional objectives are high-level irrigation and navigation. American experience and technical skill are being applied in the execution of these projects some of which, like the TVA, are multi-purpose.

Most spectacular of these projects is the dam across the Kosi River near Barahkshetra in Nepal territory, which will rise 750 to 850 ft above bedrock and be the highest in the world. Boulder Dam in the United States, now the highest, is only 730 ft. The power station at the Kosi River dam will have an installed capacity of 1.8 million kw, capable of extending electricity to every village and home in most parts of Bihar and Nepal, and leaving ample reserves for large-scale industrial development.

In addition, the Kosi River dam will make possible the irrigation of a million acres of land in Nepal and two million acres in Bihar, thus providing an annual addition of a million tons to the food production of the area. Another benefit is that the river channel, which has changed its course nine times and has devastated approximately 4,000 sq miles of land in Nepal and Bihar, will be stabilized and made fit for navigation throughout the year. Construction of the dam is expected to take ten years and cost about $300,000,000. Dr. J. L. Savage, Hon. M. ASCE, expert on dam construction, visited the site recently and gave useful advice to the Indian engineers engaged on the task.

Another important dam will be built across the Godavari River, near Polavaram, about 20 miles above

(*Continued on page 82*)



APPRECIABLE INCREASE IN AMOUNT OF CONCRETE required for bridge job over quantity specified in contract would be unfair to owner. Steel bascule span of bridge over Suislaw River on Oregon Coast Highway is flanked by concrete arches.

Unit-Price Bid Forms Protect Owner, Contractor and Engineer

R. B. ROTHSCHILD, JR., Assoc. M. ASCE
Haas & Rothschild, San Francisco, Calif.

BID FORMS FOR ALL TYPES OF WORK should be so set up as to protect all parties concerned. The bid items should be segregated in such a manner that the contractor can accurately estimate his costs for all operations of the work, and that any subsequent changes in quantity or condition of any or all of the items will not be unfair either to the owner or to the contractor. Outlined herein are unit items for various types of construction which have been found to be satisfactory to owner and contractor alike. This article is based on a paper presented before the Structural Division at the ASCE Summer Convention in Seattle, Wash.

CONSTRUCTION PROJECTS require the cooperation of three separate entities, three parties whose only common interest is in the completion of the job: (1) The owner; (2) the contractor, and (3) the engineer. The owner, whose primary function is to pay the bill, does not want to pay more than he has to for the required project. The contractor, on the other hand, wants to be the low bidder but at the same time has an eye for maximum profit. The engineer, besides his interest in the artistic, structural and functional qualities of the work, should center his financial interest in seeing that the owner secures bids which represent a fair price to the owner with a legitimate profit to the contractor. It is his function to provide a means of creating a meeting of minds whose views are by nature in opposition.

The wording and manner of presenting a bid form have an important significance in determining the ultimate cost of the job to the owner and assuring a reasonable profit to the contractor. When a contractor is preparing a bid which is *obviously* very risky he will naturally try to figure on the safe side. He will often provide for contingencies in his bid to take care of construction difficulties which might be expected but which in all probability will not occur. Thus when a specification is set up with a bid form which tends to throw the burden of unforeseen elements on the contractor, the chances are that the owner will pay not only for the contingencies which do occur, but also for some which do not. The intelligent answer would seem to be to set up a manner of bidding that will allow the contractor to be paid just for contingencies which do occur and can be evaluated, but not for those which are purely problematic.

On the other hand, if specifications are written intentionally or unintentionally to place *unforeseen* and *not obvious* construction hazards on the shoulders of the innocent contractor, he will consequently fail to consider costs of contingencies, with the result that he will suffer a serious loss. When unforeseeable risks are eliminated from the contract by a proper bid form, then the contractor is saved from these pitfalls.

It has been a sad fact in the construction business that when a contractor bids a job too low everybody concerned suffers. This contractor will unconsciously take unnecessary risks which may prove very costly in life and dollars, and he may even cut down on the quality of his work. If he loses too much money the bonding company will have to take over the job, the progress of the work will be greatly delayed, and the engineer and the owner will be put to a lot of unnecessary trouble and expense.

The unit bid form is the most expedient way of arriving at a solution on heavy construction and other types of projects where the hazards are of great consequence. However, in the past many unit bid forms have lost sight of their purpose and become merely a mathematical nightmare for the contractor instead of a means of reducing his hazards.

On the other hand, unit bid forms should be set up so as to discourage the unbalancing of bids. If this is not done, then the lowest bid based on the assumed bid units may prove to be more expensive when the final certificate is issued and the final quantities are settled.

Based on this general approach, the following suggestions are offered for the preparation of unit bid forms.

Tunnels

Bidding on tunnel work is always hazardous by the very nature of the construction operations to be carried on. There are, however, several ways of reducing the bidding hazards to a minimum.

The bid form of the specifications, except in very unusual circumstances, should never require a unit price bid per linear foot of tunnel. The amount of materials required for the tunnel construction is unknown and indefinite at the time of bidding, which has an important influence on the preparation of the estimate. For example, it is almost pure guesswork to try to determine the relative amounts of steel liner plates or timbering that would be required in most tunnels. Likewise, it is highly impracticable to estimate the quantity of grout that will be required to fill the voids behind the tunnel lining. The quantities of these materials depend so much on the type of ground through which the tunnel will be driven that they cannot be roughly estimated prior to actual excavation.

The contractor is not the designer of the tunnel, and therefore should not be required to assume all of the responsibility for the amount of materials entering into its construction. A proper unit bid set-up will permit the contractor to prepare an estimate of cost, properly calculated to care for bad ground conditions, and at the same time reduce the final cost to the owner if ground conditions turn out to be more favorable than anticipated.

The unit items for tunnel work contained in the following review have been found to be most satisfactory from the standpoint of both the owner and the contractor:

1. **Excavation** will be paid for at a unit price per cubic yard. The quantity will be measured for payment to a described "B" line, which line is a given distance outside of a prescribed "A" line. The "A" line is that line within which no unexcavated material or timbering shall remain. The distance between the "A" and "B" lines is specified to allow for some possible overbreak in the excavation. The locations of the "A" and "B" lines can be changed by the engineer, but the distance between them shall remain constant. Such a clause gives the engineer an opportunity, after the contract is awarded, to change the required diameter of the tunnel section or thickness of the concrete lining, but still allow the same percentage of overbreak. Should the tunnel section already be excavated and the engineer desire to enlarge it, then the additional excavation will be paid for at the unit price bid for tunnel enlargement.

2. **Excavation** for tunnel enlargement will be paid for at the unit price per cubic yard. It will be that quantity of material which lies between the original tunnel section and the revised "B" lines.

3. **Timbers** as ordered on approval by the engineer will be paid for at the unit price per thousand board feet. Timbers in a tunnel always materially slow up the progress of the excavation and invite the further hazard of being blasted down and again installed. The contractor should be paid for temporary timbers as well as permanent timbers, inasmuch as he is often required by the safety inspectors or by good practice to install timbers merely for protective purposes rather than for supporting heavy ground.

4. **Steel tunnel liner plates** as ordered or approved by the engineer will be paid for at the unit price per pound.

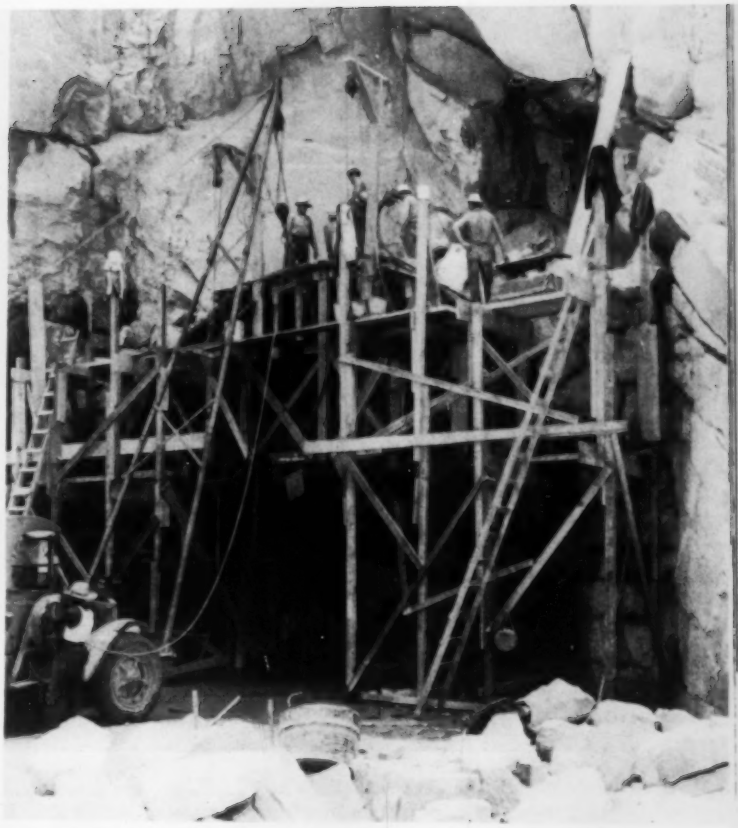
5. **Pumping** will be paid for at the unit price per thousand gallons.

6. **Concrete lining** will be paid for at the price per cubic yard measured from the inside surface of the tunnel lining to the prescribed "B" line, except in supported sections with tight lagging where the measurement shall be to the inside of the lagging or metal lining. Cement for concrete will be paid for under another item.

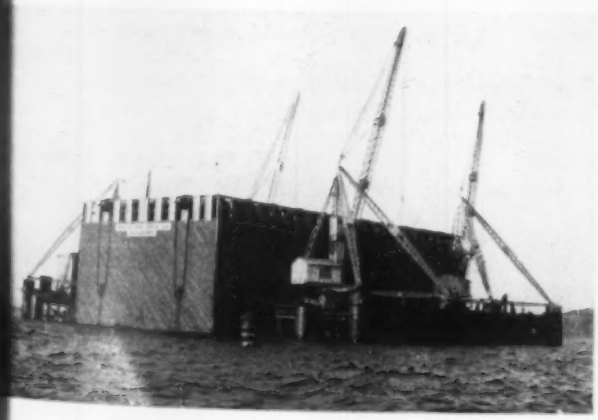
7. **Reinforcing steel** will be paid for at the unit price per pound. Extra lengths in laps and splices which are authorized, will be allowed in the pay quantities.

8. **Grout** will be paid for at the unit price per cubic foot. The quantity will be the total of the volumes of cement and sand actually placed. Cement will be paid for under another item.

9. **Grout pipes** will be paid for at the unit price per pound.



AMOUNT OF materials required for tunnel construction is unknown and indefinite at time of bidding. View of tunnel between Grizzly Creek and Pulga, on Feather River Canyon Highway, California, shows shaping and setting of granite stones over portal.



UNIT COST per volume of caisson work increases with depth of structure. Pictured here in early stages of construction is caisson for pier of existing San Francisco–Oakland Bay Bridge.

COST OF FURNISHING AND DRIVING PILES for any given job is at best a mere estimate since number of piles driven may remain constant while total linear feet of piles varies. Pictured here is early construction view of Stuyvesant Town, New York City housing project. Photo courtesy Western Foundation Co.

10. **Connections** to grout pipes will be paid for at the unit price for each connection.

11. **Cement** for all concrete, grout and Gunite specified will be paid for at the unit price per barrel.

12. **Gunite** of rock will be paid for at the unit price per cubic yard in place.

Pile Driving

The total cost of furnishing and driving piles for any given job is, at best, a mere estimate. Therefore, a bid form for pile driving should be set up in such a way as to reduce the hazards of bidding to a minimum.

Two bad examples of pile bid set-ups are as follows:

The first is the lump-sum bid. In the case where the lengths of the piles are specified, a lump-sum bid often works against the best interests of the owner in that the specified lengths may not be satisfactory for the job. When the lengths are not specified, unwarranted responsibility is thrown on the contractor, even when pile test data have been made available.

The second example of a bad pile bid set-up is the unit bid price per linear foot of pile for furnishing and driving piles. This bid form does not take into consideration the fact that the number of piles to be driven may remain constant while the total linear feet of piles varies. This form encourages extreme unbalancing of bids by the contractor in order to protect his bid, which may work against the best interests of the owner and more often will prove very expensive to the contractor.

In a pile-driving specification, it is well for the engineer to specify the number, length and location of certain test piles to be driven with a required height of driver and size of hammer. After the contractor has driven these test piles, the engineer should determine the length of piles he wants for the job.

It is best to request bids only on those items the quantity of which can be estimated in advance of the bidding with reasonable accuracy. The quantity of such items as pile splices is usually very uncertain, and inasmuch as the unit price varies greatly with the quantity, they should be paid for at an agreed price, or at cost plus.

Unit Bid Set-Up for Pile Driving

A suggested unit bid set-up is as follows:

1. **Furnishing and driving test piles** will be paid for at a lump sum. (Quantity, location and length of test piles will be specified.)

2. **Driving** of piles will be paid for at the unit price per pile.

3. **Furnishing** of timber piles will be paid for at the price per linear foot of piles. Pay quantities will be the total length as ordered by the engineer and delivered to the job, with the usual allowance of 2 ft over or under any specified length.

4. **Load tests** will be paid for at a lump sum. (Number and size of tests will be as specified.)

5. **Pile splices,** if required, will be paid for on a cost plus basis or at an agreed price.

6. **Pile shoes** will be paid for at the unit price for each.

Caissons and Cofferdams

It is difficult to establish any standard bid for caissons or cofferdam work, as the conditions of each job are usually entirely different. However, in general, it should be considered that the unit cost per volume of caisson or cofferdam work increases with the depth of the structure; also, that structural concrete materially differs in cost from mass concrete.

A possible form of bid set-up for large bridge-pier caissons is:

1. The volume of the caissons down to, and not more than 2 ft beyond the proposed depth will be paid for at the unit price per cubic yard of caisson. The minimum proposed depth should be as specified.

2. The possible increased volume of caisson beyond 2 ft of the proposed depth will be paid for, at the contractor's option, on a cost plus basis or at the original unit price per cubic yard of caisson.

3. Concrete seal inside of the caisson will be paid for at the unit price per cubic yard.

Sewer and Water Lines

Bidding on sewer and water lines is, to a certain degree, similar to bidding on tunnels in that the quantity and character of the excavation are usually unknown. The bid form set-up might be similar to that for a tunnel. The following are suggested bid items:

1. **Excavation** will be paid for at the unit price per cubic yard measured between certain specified limits of width and depth. These limits would depend upon the nature of the ground and also the location of the ditch, such as in city streets or in open country. Excavation for structures should be classified separately from trench excavation. A further classification should be made between earth and rock excavation.

2. **Backfill** of excavated materials will be paid for at the unit price per cubic yard of backfill.

3. **Imported backfill** will be paid for at the unit price per cubic yard in place.

4. **Lagging** of trench as ordered or approved by the engineer will be paid for at the unit price per thousand board feet.

UNIT BID FORM is most expedient way of arriving at solution on heavy construction and other types of projects where hazards are of great consequence. In view, dragline with 70-ft boom removes overburden of earth and rock to be used as fill for Granby Irrigation Dam on Colorado River.

5. **Concrete** and reinforcing steel for conduit will be paid for at a unit price.

6. **Concrete pipe** and steel pipe will be paid for at the unit price per linear foot.

7. **Beveled courses** in steel pipelines will be paid for at the unit price for each.

8. **Manholes,** special sections, valves, expansion joints, special casting, et cetera, will be paid for under separate items at the unit price per pound or per item.

9. **House sewer laterals** which intersect the new conduit will be paid for at the unit price for each.

Buildings

Often the bid forms for buildings require the contractor to state, in addition to his lump-sum bid, a unit price for additions or deductions of concrete, which unit price is to include the cost of concrete, forms, reinforcing steel and cement finish. This set-up is unsatisfactory in that the cost per cubic yard of concrete in various parts of a building is extremely variable.

Generally, in a lump-sum contract, the best methods of taking care of the cost of any change in the quantity of concrete are: (1) An agreed price between the engineer and the contractor; and (2) time and materials.

However, if it should be necessary for a bid form to require unit prices for additions or deductions in the concrete quantities, there should be separate unit prices taken for each of the following items: Concrete, forms, reinforcing steel and cement finish. Also, separate unit prices should be taken for both additions and deductions.

When specifications for a building call for unit bids for additions and deductions of excavation, there should be separate units for hand work and for machine excavation, for rock and earth, and also for lagging. The following is often inserted in specifications for building excavations:

"Bids shall be based upon the following:

"(*a*) That existing surface elevations are as indicated;

"(*b*) That stone or rock will not be encountered;

"(*c*) That no pipes or other artificial obstructions will be encountered.

"In case actual conditions differ from those stated or shown, an adjustment in the contract price will be made."

Such a statement obviously encourages legitimate bids on what ordinarily would be uncertain work.

Dams and Irrigation Structures

The bid forms for dams and irrigations structures should combine the principles mentioned in the foregoing.

Excavation and Bid Quantities

In specifying unit bids for excavation for construction work in general, there should always be a separate classification for rock and earth, for

(*Continued on page 82*)

Oil Companies Adopt Welded Steel Housing

COMPLETE WITH AIR CONDITIONING, prefabricated steel houses built for oil drilling personnel are transported by barge from Louisiana plant of Avondale Marine Ways, Inc., to location off Louisiana coast. Houses which provide living accommodations for about 30 persons are lifted from barges by crane and placed on previously prepared pile foundations. Houses are livable upon connection with water and electrical services.

Toll Bridge Authority Directs Construction of Two New San Francisco Bay Crossings

RALPH A. TUDOR, M. ASCE

Chief Engineer, Division of San Francisco Bay Toll Crossings, State of California Department of Public Works, San Francisco

SAN FRANCISCO–OAKLAND BAY BRIDGE, completed for automobile and truck traffic in November 1936 and opened to interurban trains in 1939 is now heavily congested. To experts who have studied the problem it is evident that additional facilities are urgently needed. Positive steps being taken to that end—which promise construction of at least one more crossing between San Francisco and the East Bay within the next few years—are reviewed herein. This paper was presented before the Structural Division at the ASCE Summer Convention.

SIX LANES are provided for light automobile traffic on the upper deck, and three lanes for buses and trucks and two tracks for interurban trains on the lower deck of the present San Francisco–Oakland Bay Bridge. In 1947, a total of 25,877,837 vehicles and 18,561,506 interurban passengers used the structure as compared with an estimated annual capacity of 28,000,000 vehicles and 50,000,000 interurban passengers. The interurban facilities across the bay present no immediate problem in so far as congestion is concerned. Such is not the case with automobiles and trucks. There is good reason to believe that the accelerated general growth of the San Francisco bay area will continue for some time, and with it the bridge's vehicular traffic.

Although tolls have been reduced from an original average of 66.6 cents per vehicle in 1936 to 29.7 cents in 1947, the total revenue has been sufficient so that all bonds will be retired by 1952. Certain other obligations will be paid for from tolls in another year. The state law requires that the bridge then become toll free unless additional facilities are built sooner and tolls collected on all crossings to pay the joint debt. Certainly no substantial amount of money can be borrowed for an additional crossing if the existing bridge becomes free, and it is doubtful whether tolls can be replaced once they have been removed. Hence it becomes urgent that financing and construction of added facilities be initiated some time before 1953. Fortunately, the rapid reduction in the existing debt and the ability to continue the earning capacity of the first crossing go far toward assuring the financing of new facilities.

State of California Studies

In October 1945, the California Toll Bridge Authority directed the State Department of Public Works to make a study of the problem and advise how best to provide additional facilities between San Francisco and the East Bay communities. Eleven different crossings were investigated. Terminal areas in San Francisco ranged from Telegraph Hill on the north to below Hunter's Point on the south. In the East Bay the northernmost terminal considered was adjacent to the existing bridgehead and the southernmost was on Bay Farm Island south of Alameda. Bridges and tubes for vehicles and railroads were considered.

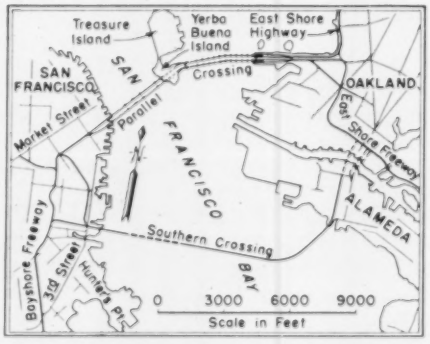


FIG. 1. LOCATION MAP SHOWS proposed additional crossings of San Francisco Bay and principal freeway and approach connections. Parallel crossing is to be duplicate of existing San Francisco–Oakland Bay Bridge except for omission of interurban tracks. Main channel section of southern crossing will be three parallel two-lane subaqueous vehicular tubes with causeway connections to each shore.

A great many traffic data were available and particularly the preliminary information of an extensive metropolitan bay area survey then under way. A limited amount of funds were available for a few wash borings, principally in the area south of the existing bridge for which information on subsurface conditions is meager.

As a result of these studies, the State Department of Public Works concluded that an additional bridge, without rail facilities, could be financed and built and should be located in the general vicinity of the existing structure. It favored a plan calling for a parallel bridge 325 ft to the north and pointed out that the effectiveness of a new crossing would depend particularly on the arrangement and location of approach structures and street connections.

This location was recommended by the Department primarily because it best suited the requirements of existing traffic. The Department was of the opinion that regardless of the location of the crossing, traffic must be given convenient access to and from downtown San Francisco where the heaviest West Bay origin and destination count centered. Furthermore, the estimated cost of such a structure is substantially less than that of most other plans considered.

Army-Navy Board Studies

In March 1946, Congress authorized a joint Army-Navy Board to study the problem. This board considered substantially the same loca-

MID-AFTERNOON WEEKDAY TRAFFIC on San Francisco–Oakland Bay Bridge is pictured here. During morning and evening peaks traffic is much more congested and relief is needed. Total of 25,877,837 vehicles using bridge in 1947 is close to estimated annual capacity of 28,000,000 vehicles.

tions as directed by the State Department of Public Works. Foundation, traffic, and other data were freely exchanged. The board held a series of public hearings and studied the matter intensively for almost a year.

In its final report, this board favored a combination mole, causeway and subaqueous tube between Alameda on the East Bay and Army Street in San Francisco. This location is about four miles south of Yerba Buena Island and a little over a mile north of Hunter's Point; it has become known as the "southern crossing" in contrast to the state-favored "parallel bridge" (Fig. 1).

The Army-Navy Board favored the southern crossing as offering the greatest opportunity for future development of the area and decentralization of traffic. The board also concluded that a parallel crossing would be only a little less desirable and in fact would best serve immediate traffic demands. The board also urged the construction of a subaqueous tube across the bay for interurban trains.

State Toll Bridge Authority Action

As would be natural, there were strong advocates for each crossing. Each clearly had substantial merits. The principal differences of opinion between the two investigating bodies were in the cost, time of construction, and relief that would be afforded the existing bridge and bridgehead areas by a southern crossing, and the general service that would be rendered to the traveling public. More exhaustive studies of foundation conditions and traffic would be necessary to throw additional light on the matter and particularly to verify assumptions regarding the southern crossing. These things the Toll Bridge Authority had to consider and act on for it is the only assured source of funds and will undoubtedly sponsor the work.

In November 1947, the Authority met and after extensive deliberation concluded that both crossings should be built and, if possible, simultaneously. If further studies show that there is insufficient credit to do this, then one crossing must be selected for first priority. The studies now under way must develop the answers to these questions.

In January 1948, C. H. Purcell, M. ASCE, Director of Public Works for California and chief engineer of the first bridge, set up a new division in his department to conduct the additional studies and ultimately to build the new crossings. Offices have been established in San Francisco and work is well under way.

One of the principal unknowns is the foundation condition along the southern alignment. A few wash borings have been made in this vicinity. Rock is known to be too deep to reach and at least the top layer of bay-bottom sediment is very soft and unstable. A contract has been let to make about 32 borings on this line and it is planned to recover a large number of undisturbed soil samples which will be inspected and tested to enable the engineering staff to evaluate the material as a medium for supporting the structure.

The Army-Navy proposal contemplates building artificial islands on each side of the main shipping channel. These islands will be reached from the shore by fill and reinforced concrete causeways. Three two-lane subaqueous tubes are proposed to carry the traffic under the channel and from one island to another. The islands would serve to support the transition sections from the surface to the subsurface roadways.

It will be necessary to stabilize these artificial islands against any substantial settlement once the tubes have been built or there may be serious consequences. The method and cost of accomplishing this stabilization cannot be determined until the extensive subsurface explorations now under way are completed.

A limited number of additional subsurface explorations are being made along the line of the parallel crossing. Available information is much more extensive in this area and the problems are quite different. In all probability a bridge here will for all practical purposes be a duplicate of the original, and designs and methods of construction will be comparable.

Future Traffic and Revenue

Future traffic and revenue are being extensively investigated. Fortunately a most complete study of all vehicular traffic in the metropolitan bay area is under way and essential information will shortly be available. This is a joint undertaking of the State Division of Highways and the Federal Public Roads Administration. The data are voluminous and will give a more complete picture of traffic across the bay, traffic on the streets and highways in communities around the bay, and traffic on the highways leading into the bay area than has ever been available in the past.

The picture of vehicular movements as they exist today in the area will be complete. The problem, as always, is to predict what such movements will be in the future. The forecast is complicated by the very rapid population and business growth around San Francisco Bay and by the extensive plans for freeways and other traffic facilities that are now being carried out. It is not easy to predict the effect of one or more additional bay crossings, but that must be done.

All parties recognize the vital need of adequate approaches for any or all crossings that may be built. The bulk of the traffic in the West Bay does not move far beyond downtown San Francisco. Here it is necessary to distribute transbay traffic to a number of busy streets not too widely separated. At the same time the effect of local traffic, which greatly exceeds bridge traffic, and traffic entering San Francisco from the north and south must be considered. In the West Bay, the problem is quite different. Bridge traffic distributes itself widely to the north, south, and southeast. This fact makes the problem no less difficult. In either event carefully planned approaches that are both extensive and expensive must be provided.

It is essential not only that the traffic investigations contemplate the best possible service to the traveling public, but also that a measure of the future transbay traffic and revenue therefrom be established. Such an estimate, together with that of cost of construction of the two crossings, will very largely control all financing, since the revenue bond method will be employed.

(*Continued on page 86*)

ONE OF HEAVIEST ROCK CUTS on North Santiam Highway project is at approximate site of Detroit Dam. Vertical distances as great as 400 ft from top of cuts to bottom of adjoining fills illustrate steepness of slopes and rugged character of terrain. One 1½- and three 2½-cu yd diesel shovels equipped with rock buckets handle blasted rock excavation. Latter average around 1,500 cu yd each per shift.

North Santiam Highway Follows Difficult Route Near Cascade Summit

Costly right-of-way dictated by Willamette Valley Flood Control Plan poses many design and construction problems on 15.6-mile stretch of highway in western Oregon

J. F. CAMERON
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OF IMMENSE IMPORTANCE to the present and future development of the State of Oregon, the North Santiam Highway—providing the shortest route between the crowded cities and productive farms of the mid-Willamette Valley and a comparatively unsettled and undeveloped central eastern area—is proving to be one of the most difficult highway jobs ever undertaken in the state. Original plans for the 15.6-mile route through rugged mountainous terrain were considerably complicated by the formulation of the War Department's Willamette Valley food control plan in 1936. Under the plan, Detroit Dam will create a reservoir covering the original projected highway to a depth of 270 ft. Highlights of the engineering and construction problems which increased the prewar estimate of cost from $1,260,000 to a present estimated total of $5,700,000 are given herein. This article is based on a paper presented by the author before the Construction Division at the ASCE Seattle Meeting.

CONSIDERING THE MARVELOUS tools now available to the construction industry and the monumental structures built in past ages entirely by hand labor, we should be humble in describing to-day's great engineering projects. However, certain current projects can be characterized as unusual without minimizing the achievements of the past. The North Santiam Highway now under construction in the foothills of the Cascade Mountains of Oregon belongs in that category. This 15-mile project is costing an average of $380,000 a mile. In fact, one mile will cost $770,000.

As a matter of public economy, construction of this final link in the route between Niagara and Detroit is essential. Large sums have already been spent on adjacent sections, and this investment cannot be fully utilized under the travel restrictions imposed by the present low-standard North Santiam road. Thus the construction of the new highway cannot be longer delayed. Another and more immediate reason is that construction of the Detroit Dam, a part of the Willamette Valley Project, will eliminate, by flooding, all existing means of transportation between eastern and western Oregon via the North Santiam Valley.

EXISTING ROAD AT Mayflower Creek, built in 1925 as Forest Development project, is little more than truck trail imposing restrictions on travel over 15-mile route between eastern and western Oregon via North Santiam Valley.

LOGGING RAILROAD follows bottom of canyon, route originally selected for highway before formulation of flood control plan. View upstream from Detroit Dam site shows present road on slope at left with clearing for projected highway above.

TEMPORARY FLUME (left) is constructed over railroad-highway detour to carry drainage from Sardine Creek during construction. New channel (right) is excavated to entrance of triple 8x8-ft box culvert. Slope at right will be paved above high water of widened channel. Structure is located 70 ft above old stream bed to achieve saving of 400 ft of structure and provide space to waste 100,000 cu yd of material in pocket above roadway section.

IN THE CONSTRUCTION of the North Santiam project the most modern types of heavy earthmoving equipment of varying design and capacity are meeting a severe test. Approximately 2,500,000 cu yd of material must be moved, some of it to a maximum distance of 2½ miles. The average haul of all material is approximately one-half mile.

The present road, which has never merited the term highway, was built in 1925. It is little more than a truck trail, hewn from a rocky mountain side. The natural and easier location in the bottom of the canyon had already been preempted by a logging railroad. In relocating the highway, a line based on a water grade was initially selected at the bottom of the canyon, along the route of the present railroad. The estimated cost was high, though not excessive. No unusual difficulties were evident. The railroad right-of-way was to be surrendered with the stipulation that a highway would be constructed which would provide all-weather transportation for the logging and lumber industry. At present the railroad transports annually some 20,000,000 fbm of logs and lumber to mills and plywood factories in the Willamette Valley.

The reconstruction program was deferred and all original estimates of cost were rendered useless when the War Department's Willamette Valley flood control plan was formulated in 1936. In general this plan, known as the Willamette Valley Project, contemplates a broad development for flood control, navigation and hydroelectric power, estimated to cost some $400,000,000 and to save annually some $7,000,000 in flood damage. Hydroelectric facilities will provide approximately 387,000 kw. The North Santiam River Valley figures prominently in this project. Plans include what is known as the Detroit Dam and reservoir, with a smaller regulating dam at Big Cliff. Impounded water will cover the originally projected highway location to a depth of 270 ft.

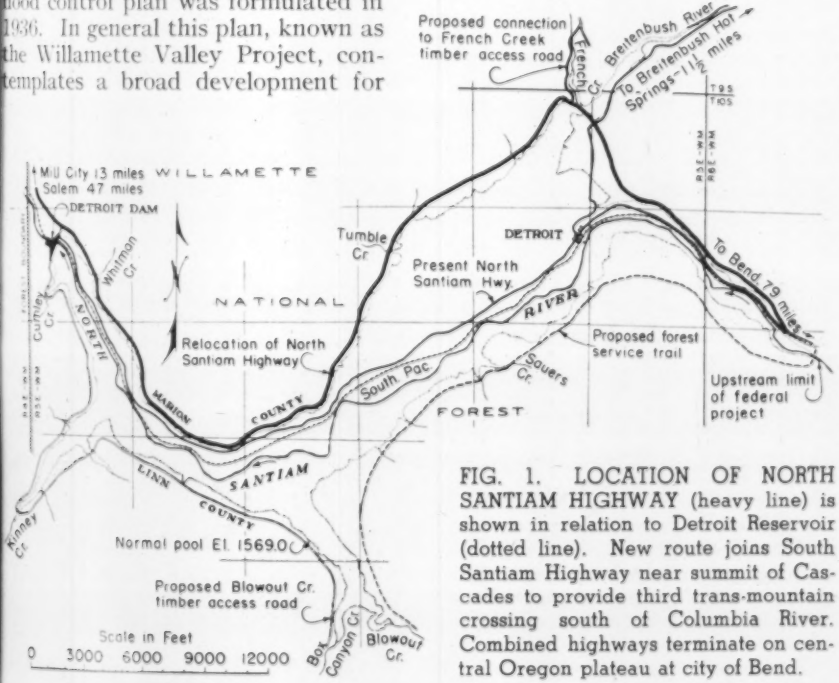


FIG. 1. LOCATION OF NORTH SANTIAM HIGHWAY (heavy line) is shown in relation to Detroit Reservoir (dotted line). New route joins South Santiam Highway near summit of Cascades to provide third trans-mountain crossing south of Columbia River. Combined highways terminate on central Oregon plateau at city of Bend.

An operation planned as normal highway construction on a uniform grade, already partially constructed, was by necessity converted into a feat of supporting a highway 300 ft higher, on the 33-deg rock slopes of the canyon. Support does not adequately describe the methods required to sustain the road, since a portion will partially cling to the mountain side on a concrete trestle-type half bridge. At this location steep rock cliffs preclude complete bench excavation.

Elevating the roadway 300 ft above the projected location had the effect of a chain reaction on costs. Estimated costs of earthmoving, drainage control, maintenance of traffic and other original items were expanded out of all semblance to their former values. The original prewar estimate of cost increased from $1,260,000 for the location on the valley floor, to $3,600,000, for construction at the higher elevation. To avoid the water of the reservoir it became necessary to build 15.6 miles of highway instead of the 12 miles required on the valley floor. Because of increased unit prices since the war, the estimated cost now totals $5,700,000.

Cost of the highway project is shared by the Public Roads Administration, the Oregon State Highway Commission and the Corps of Engineers. The respective shares of the participants were determined by the estimated difference in costs between a highway of modern standards constructed on the original projected location, without considering the dam and reservoir, and one of similar standards built on a location dictated by the maximum pool level. The Public Roads Administration and the state bear the full estimated cost of the former. The Corps of Engineers contributes the increased cost due to the latter, plus additional increased costs made necessary by provision for drawdown protection.

Rapid runoff of flood dimensions from the steep draws requires expensive drainage tunnels and oversize

TRESTLE-TYPE REINFORCED CONCRETE BRIDGE supported on long 6-sq ft columns hugs steep rock cliff, with other half of roadway benched in solid rock. Contractor's service road is at right, railroad-highway detour road below at left.

reinforced concrete box culverts. A temporary flume of river-size capacity is required to carry flood water over the railroad and highway detour. Maintenance of highway and railroad traffic in the interest of safety has become a major and costly problem. Portions of the old road, which were to have served as a detour, will be wiped out. It is necessary to plank and widen $2^1/_2$ miles of railroad embankment for highway use and to coordinate train and vehicle movements, with each other and with construction operations.

Small draws requiring normal fills became huge embankments in the 250,000-yd class. Average cut volumes jumped to 60,000 cu yd. Some cuts run to 100,000 cu yd, all in rock of unpredictable and non-uniform hardness. Sufficient clay is present to make wet-weather operations precarious on the steep pioneer roads.

In addition, an element not frequently encountered in highway construction entered the picture. Rapid drawdown of water in the reservoir and wave action will endanger all fills and slopes not established on stable foundation or protected by expensive riprap. Extensive studies were required to determine a location reasonably safe from sliding.

Design Provides for Heavy Logging Traffic

The design meets the standards required for a Public Roads Administration 100-P-50 traffic classification, that is, 100 vehicles, predominantly passenger-car type, in an average summer maximum hourly period, traveling at a design speed of 50 mph.

The geometric features of the design are briefly as follows:

- Maximum grade, 6 percent for 1,610 ft
- Normal maximum grade, 2.5 percent
- Maximum curvature, 11 deg for a total central angle of 104 deg, which, however, does not impair the sight distance due to open curves
- Graded subgrade width, 32 ft
- Eventual crushed rock surface width, 28 ft
- Depth of ballast course, 12 in. compacted, ballast to be composed of selected granular material with an A-3 classification or better
- Depth of crushed rock surfacing, 8 in. compacted, this material to have a closely controlled dense grading with a maximum liquid limit of 25 and plasticity index of 6; maximum abrasion, Los Angeles test, 35
- Eventual bituminous pavement width, 22 ft; thickness, $1^1/_4$ in.
- Shoulders, 3 ft wide, with a bituminous sealed rock surface
- Bridge loading, H-15 S-12
- Minimum horizontal sight distance, 300 ft, which occurs on one curve for a short distance only
- Minimum vertical sight distance, 450 ft
- All horizontal curves are spiraled.

The steep, rugged terrain and the wide variation in soil types required exceptionally careful location and design. Although a thorough preliminary soil survey was made, it was economically impracticable to determine the exact classification in every cut. As a result, shrinkage and swell factors in some cuts have changed considerably from the original estimates.

Slight shifts in alignment to effect a proper balance of quantities often resulted in a major change in quantities. In one case a changed classification resulted in a saving of 50,000 cu yd of embankment. Field redesign was an important factor in securing maximum economy, attaining a proper balance of quantities, and maintaining the standard requirements.

The mixed character of the traffic with its various requirements posed some difficult problems in design. Curves sharper than 11 deg are decidedly hazardous when the traffic includes long loads of logs. The average log load is 46 to 50 ft in length; loads 75 ft in length are sometimes encountered; and permits have been given for loads 110 ft long. Sharper curves normally require correspondingly heavier superelevations. Under conditions of snow and ice, logging trucks will slide on the superelevation, endangering all classes of traffic. There is little possibility of a compromise in superelevation which will satisfy the requirements of both heavy log loads and fast-moving passenger cars.

Because of the destructive action of heavy log loads, a greater thickness of ballast course is required. Heavy stresses occur in the subgrade from

CULVERT PIPE IS LAID by imperfect trench method. Material is compacted and trench excavated as shown here. Backfill over pipe is not compacted.

UPPER 100 FT OF CULVERT will be laid on 85-percent grade. Steep grade makes it necessary to lay this culvert section by section as height of fill increases.

PIONEER ROADS are so steep that as many as five different types of earthmoving equipment are used in average cut. Crawler-type tractors occasionally slide out of control on 30 to 40 percent grades. Carrying scrapers are employed whenever foothold can be found or when grade on pioneer roads is reduced to point where they can operate. Earthmoving equipment repair costs are heavy, some $200,000 worth of spare parts having been purchased to date on one $3,000,000 contract.

lastic defor ation and rebound of the subgrade soils under each passing xle of a loaded log truck.

Reservoir Drawdown Influences Design

Past experience in the construction of reservoirs has demonstrated the destructive results of the forces which operate on saturated fills and natural slopes extending into a reservoir. These same forces must be considered in the design of earthfill dams or levees. The most severe conditions are encountered in the presence of silty or silty-sand soils where rapid drawdown of the reservoir may occur. These types of soil are relatively impervious and drainage through them takes place slowly. Should rapid drawdown occur, landslides may be predicted with a fair degree of certainty. When the soils are free draining or the drawdown is very gradual, the severity of the forces is decreased.

When a reservoir is full, submerged soils become fully saturated. Complete saturation of the soil creates a condition of buoyancy within the mass which tends to reduce the frictional forces maintaining stability. Reduction in the pool level removes a lateral or normal force equal to the pressure of water against the upstream face of a dam. When this outside force is too rapidly removed, the combined effect of increased weight plus decreased frictional resistance creates an unstable condition. A destructive landslide and the loss of the roadway may follow.

The present design for the Detroit Dam contemplates a normal pool elevation of 1,511 ft and a maximum pool elevation of 1,570 ft. It is probable that storage between these levels will, at some later date, be used for power production with occasional rapid drawdown if floods appear imminent. It is estimated that the pool level may be drawn down at the rate of 59 ft in twelve days.

As part of the location study, the Public Roads Administration made an intensive investigation of soils in projected fills and natural valley slopes. Many soil samples were taken and soil profiles prepared. In addition to the normal laboratory analysis, the cohesive and frictional values of the soils, both dry and saturated, were determined. At the time these investigations were being made, two general alignments were under consideration: (1) The lower line at an elevation 15 ft to 20 ft above the maximum pool level, and (2) a higher line reaching a maximum height of 145 ft above pool level. Most of the fills on the lower line extended deep into the reservoir. On the upper line only a few of the higher fills extended into the water.

On completion of the laboratory tests, numerous studies were made using a modified version of the Swedish Circle method of analyzing the stability of slopes. These studies covered various types and conditions of soil, stages of drawdown on natural slopes, earth or rock fills, and earth sections with protective rock blanket and key. An approximate formula developed by Terzaghi was used to determine drawdown stresses in the various types and conditions of soil encountered. Soils consisted of clay, loam, silt, sand and gravel in various mixtures and combinations, lying on the valley walls in natural slopes approaching $1^1/_2$ to 1.

Soil samples were supplied to the Army Engineers, who made a similar study verifying the results of the initial investigation. The conclusions were that the reservoir slopes at many points appeared to be just on the point of equilibrium with the possibility that, owing to erosion and drawdown of the reservoir, some failure of natural slopes could be expected. Slides in the valley walls might undercut both roadway fills and cuts where the highway follows the shoreline of the pool.

Values obtained from the stability analyses indicated that none of the fills on the lower line would be stable within themselves unless constructed entirely of rock or with a substantial rock facing. A number of fills were found to have dangerously low safety factors unless substantially keyed into firm substrata. Other fills found to be stable without foundation keying were to be placed on foundations which would have doubtful stability when fully loaded. It would be necessary to remove any plastic clay overburden. Even with these precautions it was anticipated that complete elimination of sliding could not be expected. The possibility of erosion and wave action also indicated high maintenance costs for several years.

The stabilization requirements indicated that, in the long run, the higher line would prove more economical to maintain although it was estimated to cost some half million dollars more than the low line. This higher loca-

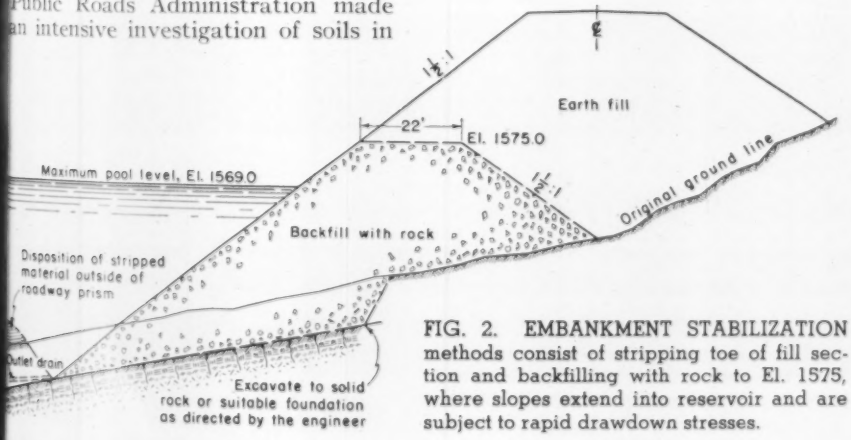


FIG. 2. EMBANKMENT STABILIZATION methods consist of stripping toe of fill section and backfilling with rock to El. 1575, where slopes extend into reservoir and are subject to rapid drawdown stresses.

VARIATION IN HARDNESS of rock is major factor in retarding excavation. Rock on portions of project is of sufficient hardness to wear conventional ross-shaped steel drill bit down to smooth surface in 2-in. penetration. New bit faced with exceedingly hard alloy and tested on job has often drilled 18- to 20-ft holes in hardest material with no appreciable wear.

tion would also provide the necessary factor of safety against the predicted slides. Starting at the dam axis 10 ft above the maximum elevation of the reservoir, the grade climbs to a height of 145 ft above pool level in a distance of 1.5 miles. It continues at approximately this elevation for an additional 2.2 miles, dropping to 36 ft above pool level at the eastern end of the reservoir, 7.5 miles from the dam axis. In the 7.5 miles only two fills extend partly into the reservoir. The submerged portion of these fills will be protected and strengthened by a rock toe 20 ft or more in thickness, extending 5 ft above maximum pool elevation, and keyed into bedrock or other suitable foundation.

Materials Vary Widely, Soil Survey Shows

During the season of 1939 a soil survey was conducted over the entire relocated project. The materials encountered in nearly all the cuts were such as to render impracticable the use of boring equipment, and it was necessary to carry on the exploration work by means of test pits. The types of material found in the pits were recorded and the data were plotted on a profile of the location line. The results were an important aid in determining the original estimate of quantities. Samples taken of the various soil types were submitted to the Oregon State Highway Testing Laboratories for determination of soil constants and classification.

Eleven widely varying types were revealed, ranging from sand, gravel and boulders to black muck. The majority of the soils had one thing in common—almost all were unsuitable as subgrade material. As a result, all fills and cuts are topped with 12 in. of either talus rock or gravel from approved pits or designated cuts.

Clearing with Mechanized Equipment

A U.S. Forest Service officer was detailed to supervise all burning operations during the fire season. The contractor was charged with the responsibility of furnishing men and fire-fighting equipment. Two factors in the clearing and grubbing operations are worth mention—the extreme fire hazard from numerous dead snags, and the extensive use of mechanized equipment.

Clearing operations were carried on almost entirely with mechanized equipment. The first operation was the construction of pioneer roads and trails using dozers. Three-man crews with portable gasoline-driven chain saws were used in falling and bucking. On straight sidehills a $^3/_4$-yd shovel with a crane boom piled the unlimbed trees at the lower limits of the right-of-way. In deep canyons piling was carried on with a D-8 tractor and double drum, covering about an acre from each setup.

Brush dozers, an adaptation of the ordinary dozer, were used in light grubbing and brush removal. The small amount of hand work employed was confined to final cleanup of small trees and roots. The average unit cost for clearing and grubbing was $1,700 an acre.

Rock Excavation Presents Hazards

Approximately 65 percent of the excavation is in solid rock. Because of the mixed character of the formations, there is a wide variation in degrees of hardness. Some cuts can be easily dug with a shovel, whereas adjacent ones may require expensive drilling in which bits dull in 2 in. of penetration. This variation in hardness has been a prevalent factor in retarding rock excavation. In several instances heavy equipment has stood idle because of the slowness of drilling work. In one shift, drilling operations may produce 400 ft of holes, while a similar operation not over 200 ft away may produce only 40 ft.

As a result, no set drilling pattern can be employed. Coyote holes are not used. Every effort is made to conserve material as practically all of it must be hauled. Since the existing highway and railroad are in the canyon below, any material lost over the side endangers and delays traffic and damages the railroad. Drilling procedure has been to work in 20-ft lifts with wagon drills and jackhammers. Because of the hazardous and special nature of the work, only the most experienced drilling and powder men can be employed. Average unit cost of all excavation is 99 cents per cu yd.

Compaction Procedure Depends on Contour

A modification of the standard methods of compaction was adopted on this project. The specifications provide that if thorough compaction can be accomplished with standard crawler-type tractors of not less than 20,000-lb gross weight, the use of special compaction equipment will not be required. Because of the amount

FORMS ARE ERECTED for construction of masonry retaining wall to catch fill slope along steep hillside. Approximately 4,000 ft of logging railroad is relocated at this point to provide for highway location.

of moisture normally present in the natural material, no special provisions for water control were incorporated in the contracts.

To effect the necessary compaction, uniform lamination of all fills is required in layers, not to exceed 24 in. for rock and 12 in. for soil. These laminations are begun at the extreme bottom of all fills. The contour of the ground dictates the manner in which the laminations are started. Although a general procedure is followed, after fills have attained a certain elevation each embankment proves to be a special case, requiring a different method of approach. In extremely steep draws the material may be transported by a circuitous route and may enter the embankment area at right angles. In other cases the fill may be laminated in longitudinal terraces, the material being dumped from one terrace to another and there spread and compacted lengthwise with dozers.

It is difficult to assess the cost of maintaining highway and railroad traffic during the construction of the project because of the intangible element of lost time caused by interference with construction operations. The tangible costs of moving one mile of track, planking another $2^1/_2$ miles for highway traffic, and convoying traffic over the detour amounted to approximately $125,000.

Half Bridge Supports Roadway on Curve

The most interesting structure on the project is a 400-ft trestle-type half bridge of reinforced concrete, built on three spirals and part of a 7-deg simple curve. This bridge hugs a steep rock cliff where one half of the roadway is benched in solid rock and the remainder is supported on long columns 6 sq ft in cross section. Outside columns have a maximum length of 44 ft; inside columns, 22 ft. The bridge is of slab-and-girder construction, heavily reinforced. Concrete is air entrained and vibrated; forms are faced with plywood. The handrail is constructed of native rock to harmonize with the surroundings. The 15-in. concrete deck will be covered with 6 in. of crushed rock which will be given a bituminous surface treatment when the roadway is paved.

Other structures include a steel-girder and concrete bridge 440 ft in length over the Breitenbush River and a 133-ft reinforced concrete slab-and-girder bridge over Tumble Creek.

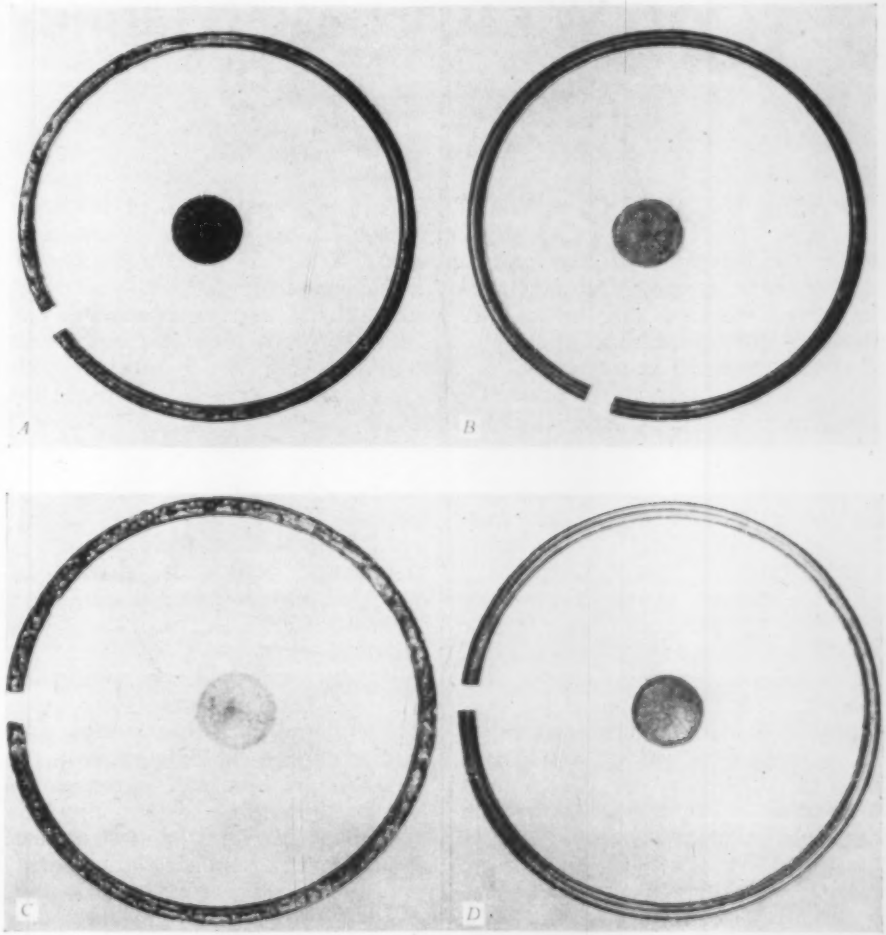
(*Continued on page 84*)

Cathodic Protection of Steel Underground Structures Demonstrated by Tests

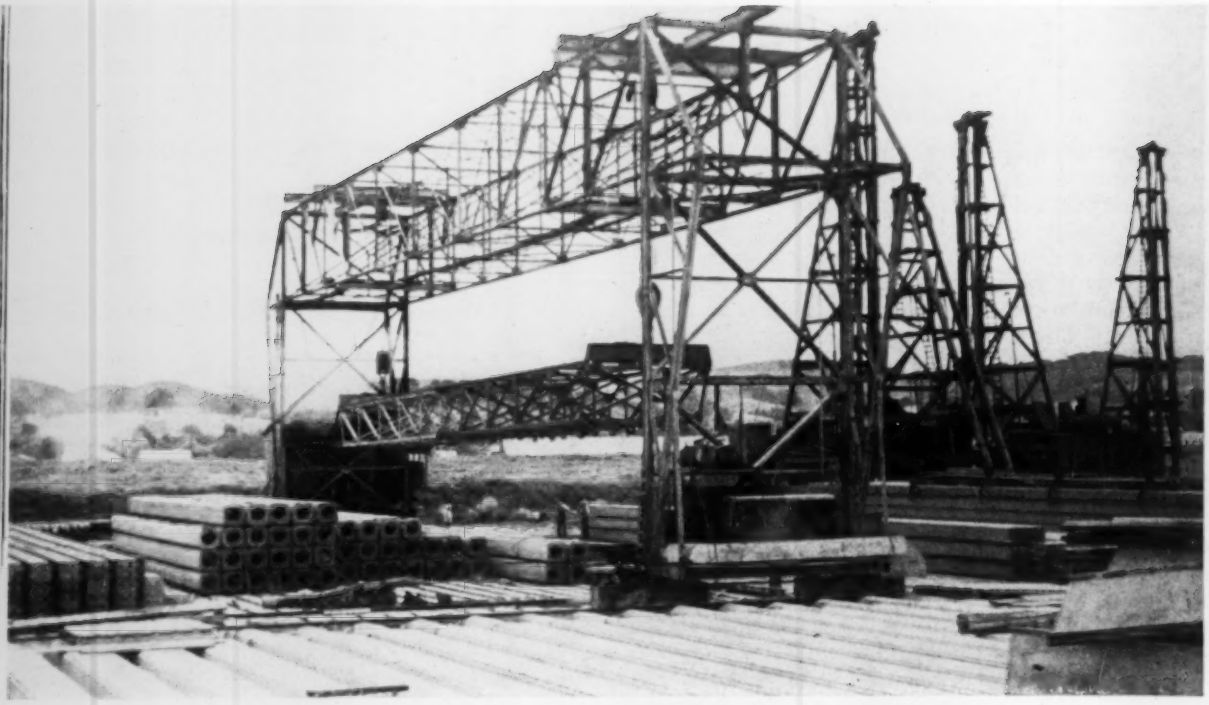
IF ELECTRIC POWER is available, a cathodic unit can be economically installed to protect steel pipelines transporting oil, gasoline, and natural gas from underground corrosion. However, such pipelines often traverse areas of corrosive soils remote from sources of power. Fortunately, as indicated in recent tests by the National Bureau of Standards, a source of energy for cathodic protection in such areas can be provided by the galvanic corrosion of bars of electronegative metals—zinc, magnesium, or aluminum—buried at suitable intervals and connected to the pipeline.

In 1941 the Bureau initiated a series of field tests in cooperation with pipeline companies by installing experimental zinc-steel couples at eight test sites. Unconnected steel rings and zinc cylinders were also buried at each test site. After periods ranging from three to six years, the units were removed and the extent of the cathodic protection was determined.

In six of the eight soils, satisfactory protection was obtained. At the other two sites, high soil resistivity and alkalinity reduced the current output of the zinc anodes, but it is probable that these unfavorable conditions could be counteracted by surrounding the anodes with a salt such as calcium sulfate. (For technical details see "Behavior of Experimental Zinc-Steel Couples Underground," by Irving A. Denison and Melvin Romanoff, *Journal of Research*, National Bureau of Standards, *40*, 301 (1948) RP1876.)



EFFECTIVENESS OF CATHODIC PROTECTION of steel against underground corrosion is illustrated by specimens used in field tests conducted by National Bureau of Standards. "A" (unconnected steel ring and zinc cylinder) and "B" (steel ring connected to zinc anode) were exposed at same site for 3.1 years. Similarly "C" (unconnected steel ring and zinc cylinder) and "D" (steel ring connected to zinc anode) were exposed at second site for 5.8 years. In "B" and "D" steel ring (cathode) has been effectively protected from corrosion by connection to zinc anode, which shows some loss of material due to flow of protective galvanic current from zinc to steel.



LOADING TRUS suspended from gan try picks up curin piles as early a seven days after cas ing. Specially forge lifting tongs grip pil under bottom cha fer at six or mo points to prevent un due strain in hand ing. At casting yar piles are loaded o 300-ton barges whic are towed distance o 22 miles to causewa site at Point Rich mond, Calif.

Precast Concrete Units Simplify Construction of West Coast Marine Structures

BEN C. GERWICK, Assoc. M. ASCE

President, Ben C. Gerwick, Inc., San Francisco, Calif.

ADOPTED BECAUSE OF ADVANTAGES in economy, time of construction and other engineering and economic factors, precast concrete is finding wider application in the construction of marine structures. Execution of work in precast concrete requires engineering skill and judgment to a high degree, and determines somewhat the limit of possibilities in design. New problems faced by the contractor in planning and using precast concrete construction techniques are reviewed herein. This article is based on a paper presented by the author before the Construction Division at the ASCE Annual Convention in Seattle, Wash.

PRECAST CONCRETE CONSTRUCTION has been an outstanding feature of several recent marine structures in the San Francisco Bay area. Foremost among these were the three submarine drydocks for the U.S. Navy at the San Francisco Naval Shipyard, built during the war; the recently completed piers for the berthing of inactive airplane carriers at the same location; and the Standard Oil Company of California's long wharf at Point Richmond, Calif. Since this latter wharf illustrates most of the principles of precast marine construction, this paper will be primarily devoted to a description and discussion of the problems encountered there and the methods used.

In general, the following principles govern the use of precast concrete methods in major waterfront structures:

1. There must be a central casting yard, properly located with respect to transportation facilities. It must be level, must drain readily, and must be free from settlement under anticipated loads. It must be equipped with soffits and base slabs upon which the units are to be precast and must have equipment for unloading and placing reinforcing steel, for handling forms, for pouring concrete, and for lifting, storing, and loading out the finished product.

2. Adequate means of transportation to the site of erection must be available. Major marine structures are dependent upon barge transportation to realize the greatest economy.

3. Equipment for driving precast piles and for handling and setting precast units must be available. This equipment must be capable of readily handling loads up to 25 tons without excessive listing of the hulls, and must be capable of setting these heavy loads with precision and speed. Where the weight is too great for a large derrick to handle, precast structures can be launched and floated into position.

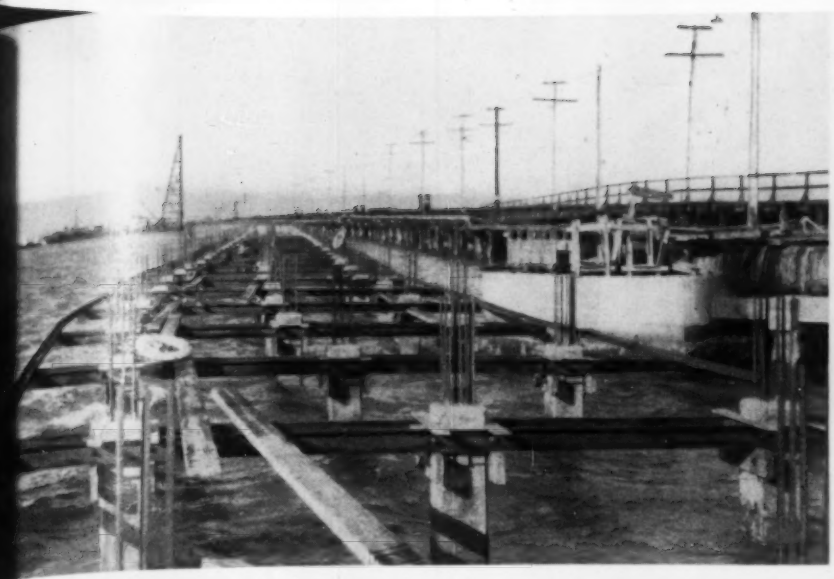
4. Experienced and skilled foremen and crews are essential to insure careful, accurate, rapid construction.

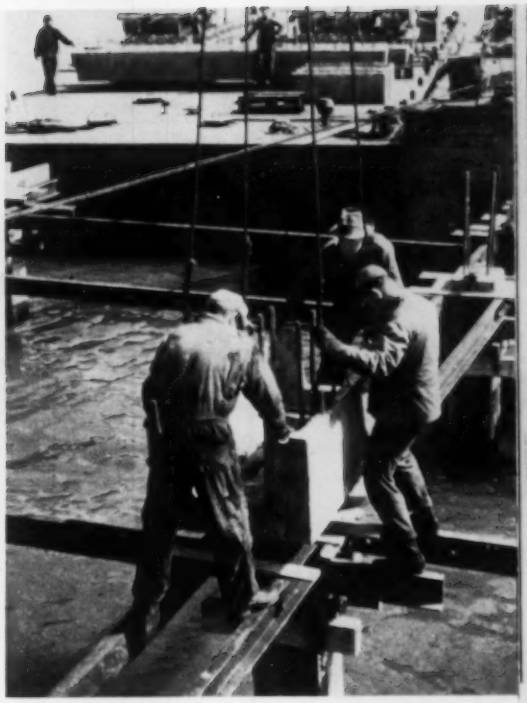
5. Supervisory personnel must be trained and able to execute accurate construction and maintain proper scheduling.

In 1946 construction was commenced on a 3,800-ft-long causeway 26 ft wide, designed for H-20 highway loading, at the site of the Standard Oil Company's Long Wharf at Point Richmond, Calif. This causeway consists of three-pile bents at 20-ft centers, the piles being of precast concrete 18×18 in. square and 90 ft in length. At each bent, a transverse concrete cap was formed in place and anchor bolts were set. Large precast deck slabs were set on the caps, over which a 2-in. asphalt concrete pavement was applied as a wearing surface.

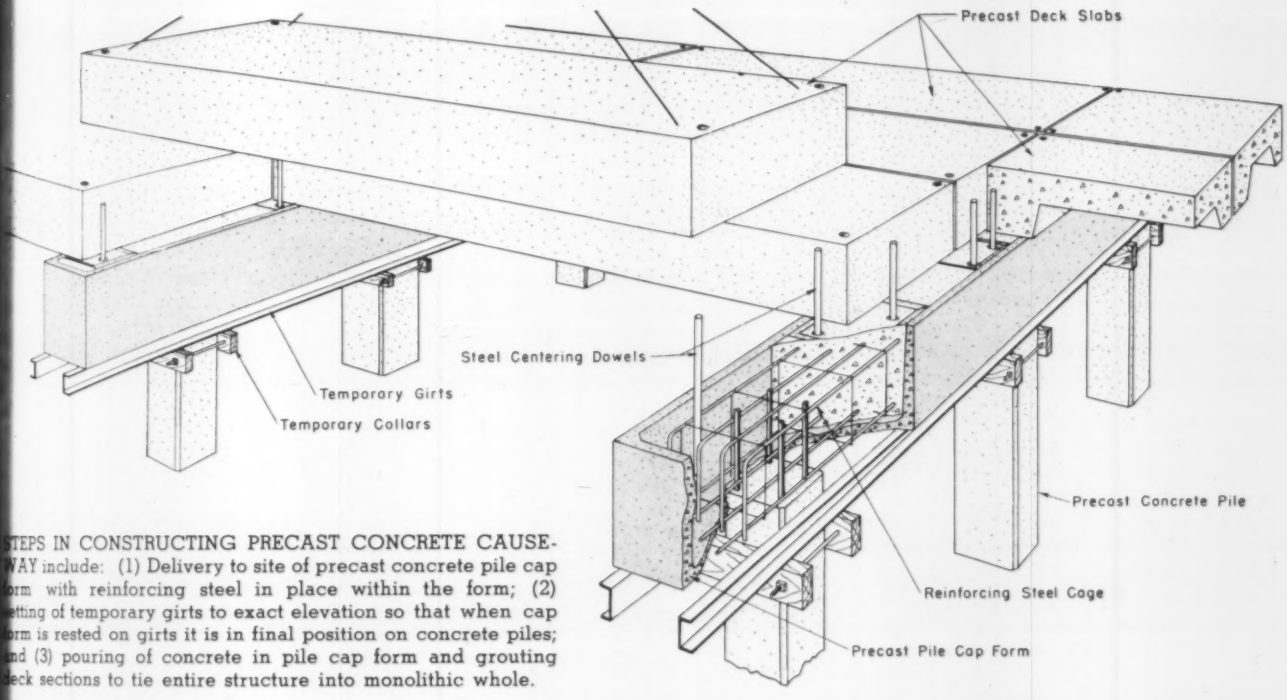
Casting Yard Centrally Located

The casting yard chosen was already in operation before construction of the causeway began. Located at Petaluma, Calif., on Petaluma Creek (a navigable stream), and central to all San Francisco Bay points, it was only 22 miles distant by water from the site of the wharf. The yard also has complete rail service and is near U.S. Highway 101, so transportation facilities are more than adequate.



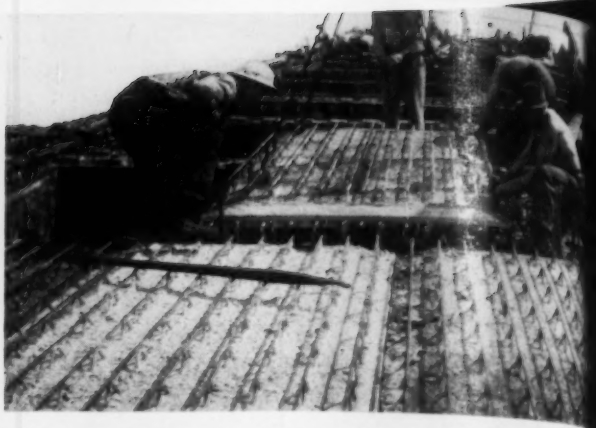


CAUSEWAY AT POINT RICHMOND, CALIF., is 3,800-ft-long and 26-ft-wide precast concrete structure designed for H-20 highway loading. Three-pile bents of 18×18-in. concrete piles, driven accurately on 20-ft centers (above), require minimum amount of falsework. Precast concrete cap forms (right) rest on steel channel girts set to exact grade.



STEPS IN CONSTRUCTING PRECAST CONCRETE CAUSEWAY include: (1) Delivery to site of precast concrete pile cap form with reinforcing steel in place within the form; (2) setting of temporary girts to exact elevation so that when cap form is rested on girts it is in final position on concrete piles; and (3) pouring of concrete in pile cap form and grouting deck sections to tie entire structure into monolithic whole.

DERRICK HANDLES LIFTING BEAM which insures uniform vertical lift in placing precast pile cap troughs. Reinforcing steel cage is set in form and anchor bolts for deck slabs are placed preparatory to pouring of concrete. Pile caps in place ready to receive precast deck slabs are seen in view, below, left. Special slabs, trapezoidal in plan, provide for curve in causeway (below, right). Strips of asphalt-impregnated fiber adjacent to anchor bolts insure perfect bearing on caps.



DESIGN OF NEW WHARVES—3,500 ft long by 120 ft wide—for Standard Oil Co. of California, at Point Richmond, Calif., calls for precast concrete piles, wood brace piles encased in concrete jackets, formed-in-place concrete caps and precast concrete deck slabs. Partial depth slabs poured in casting yard (above, left) are lowered into place on precast rectangular beams (above, right). Slabs are 12 ft long, 6 to 14 ft wide and approximately 5 in. deep.

Concrete soffits for casting 18×18-in. piles up to 115 ft in length had been previously installed, but it was necessary to construct a concrete base slab 20,000 sq ft in area for the casting of the precast deck slabs. Two lifting gantries with 125-ft-spans and 600 ft of travel served the casting yard, and trestles enabled the gantries to travel out over the barges and load them directly. Each gantry was capable of handling two 110-ft concrete piles weighing 17 tons each and could pick up and load a barge with twenty 100-ft-long piles in about 4 hours.

Piles Are Cast in Tiers

The concrete piles were cast in steel forms which had been leased from the inventor and owner, A. E. Troiel. These forms fitted the concrete soffits and enabled the piles to be cast on top of one another. Piles have been successfully cast in tiers up to ten piles high, but good practice seems to favor casting in tiers four to six piles high. Pile forms were stripped in 24 hours and raised to cast the next tier.

Building paper was used to line the concrete soffit prior to pouring the first pile. Succeeding piles were separated by a coat of emulsified paraffin only. No trouble was experienced from piles sticking to each other or to the soffits. Curing was done by spraying a membrane compound on the tops of piles after finishing, and on the sides after the forms were stripped.

From the gantry, a loading truss was suspended which enabled the cured pile to be picked up at six or more points by specially forged lifting tongs gripping the pile under the bottom chamfers. Piles have been successfully lifted seven days after casting. Piles were loaded on 300-ton barges which were towed to the site of the work and were driven by a large floating piledriver which lifted the piles at six pick-up points. Driving was with a No. 0 Vulcan hammer. Accuracy of driving was of prime importance since, in a three-pile bent, piles cannot be easily pulled to position, and since very little tolerance was possible in view of the precast members to be erected on the piles.

For the precast concrete erection procedure described in the following paragraphs, accurate girting of the piles was essential. For this reason, a wood collar was set on each pile exactly to grade, using a level, and clamped. Steel channel girts were then placed both transversely and longitudinally to hold the piles rigidly in position.

The original design called for concrete caps formed in place and coated with asphalt. Since these caps would have to be placed over the water, the contractor determined that the costs of forming, stripping and asphalting justified the use of a permanent precast concrete form. This form was designed as a thin-walled trough with three square holes in the bottom so that it could be slipped over the piles and rested on the girts. See diagram, page 47. The design was approved by the engineer, but the asphalt coating was eliminated in view of the extra protection provided by the 3-in.-thick precast concrete form.

Cap Forms Cast in Same Yard as Piles

The precast forms were cast in the same yard as the piles, using wood forms. Later the wood forms, which proved to be rather complicated and expensive, were replaced by steel forms. Since some difficulty was initially experienced in vibrating the concrete, later precast forms had walls $3^1/_2$ in. thick so that a small internal vibrator could be used.

After casting, the troughs were handled by means of a special lifting beam which insured a vertical lift at each of several points. Lifting eyes of reinforcing steel had been provided in the precast forms, and these were later bent over as ties between the precast form and the poured-in-place cap. The forms were placed by a derrick and lifting beam so as to rest on the steel channel girts which had been previously set to exact grade. Superelevation at two curves on the causeway was taken care of by setting the girts to the proper inclination.

A reinforcing steel cage was set in the form. Anchor bolts for the deck slabs were set and held in place by templates which rested on the cap form. Before pouring, the anchor bolts were checked by instrument. Concrete, which was mixed on a barge provided for the purpose, was placed by derrick.

Deck Slabs Are of Slab and Beam Design

The precast deck slabs designed for the causeway were of slab and beam design, and rested on the caps at each corner. Each slab was 20 ft long, 6 ft 7 in. wide, and weighed 13 tons. Slabs were cast at the casting yard in wood forms and transported to the site by barge. In each corner of the slab a 3-in. pipe sleeve was cast to provide a socket for the anchor bolts. Special slabs, trapezoidal in form, were precast for the curves to provide for changing angles and lengths.

A large derrick picked the slabs up at the four corners. Lifting eyes of reinforcing steel projected from the slabs and were later burnt off to provide a flush deck. The slabs were set over the anchor rods, using loosely hanging pipe sleeves as guides. As many as 60 of these 13-ton deck slabs were set in one 8-hour day by one crew.

To insure perfect bearing on the caps, strips of asphalt-impregnated fiber were set adjacent to the anchor bolts. After setting, non-shrinking grout was poured into the pipe sleeve to fix the anchor bolt and provide bearing. The joints between adjacent slabs were grouted, using a thin mix. The curb was poured in place and a 2-in. asphalt concrete pavement was laid as a wearing surface.

The causeway was completed in record time and proved both feasible and economical. Its success encour-

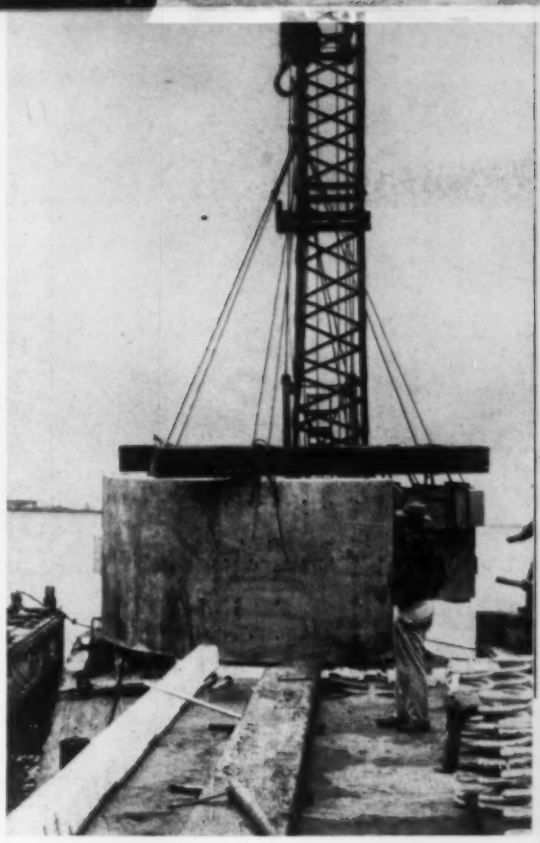
ed the engineer and the contractor extend the use of precast concrete the construction of the wharves.

Precast Concrete Wharves

Two new wharves were built for e Standard Oil Co. of California at int Richmond—a T-head wharf 00 ft in length by 120 ft in average dth, and a repair wharf 500 ft by ft. These wharves were to be ilt on the site of an existing timber harf which had to be kept in full eration for loading and unloading nkers. A greater annual tonnage is ndled over this wharf than over any her wharf in the San Francisco Bay ea. The design called for precast ncrete piles, wood brace piles en- sed in precast concrete jackets, rmed-in-place concrete caps, and recast concrete deck slabs. The tter were an unusual and revolution- y development in design, conceived the consulting engineer, A. W. Earl, . ASCE, of San Francisco.

The precast deck slabs were flat abs approximately 12 ft long, vary- g from 6 to 14 ft in width, and pproximately 6 in. in depth. The einforcing consisted of welded trusses deformed reinforcing steel. These ere set in the precast deck slabs so hat the lower half of the truss only as embedded. After the deck slabs ere in place, it was planned to pour a in. concrete top slab, which would e the structure into a monolithic hole. The precast deck slabs acted oth as the lower or tension half of he deck slab and as the bottom form or the deck.

To justify design assumptions, test ections were poured at the casting yard by the contractor and tested at the University of California laboratory under the direction of Mr. Earl and representatives of the Standard Oil Co. Tests were designed to cause failure in horizontal shear along the joint between the precast slab and the poured-in-place concrete. The first slabs were cured by water and had a specially roughened finish. Later tests were made using three heavy coatings of membrane compound to cure the lower or precast half in an attempt to get the worst possible conditions. In all tests, failure finally occurred in the steel at the calculated yield point. There was no failure at the joint. Samples cut from the test specimens after failure were so closely knitted that the joint could not be determined by eye.



FIVE MOVABLE PRECAST CONCRETE CORNERS weighing 26 tons each protect Point Richmond wharf from damage by oil tankers, tugs and barges. Constructed in casting yard, units are loaded on barge and towed to site. In photo, corner is lifted by derrick using wire-rope slings through sleeves in beam. As precast corner is set, 6 large springs are simultaneously slipped into place and other fittings are matched.

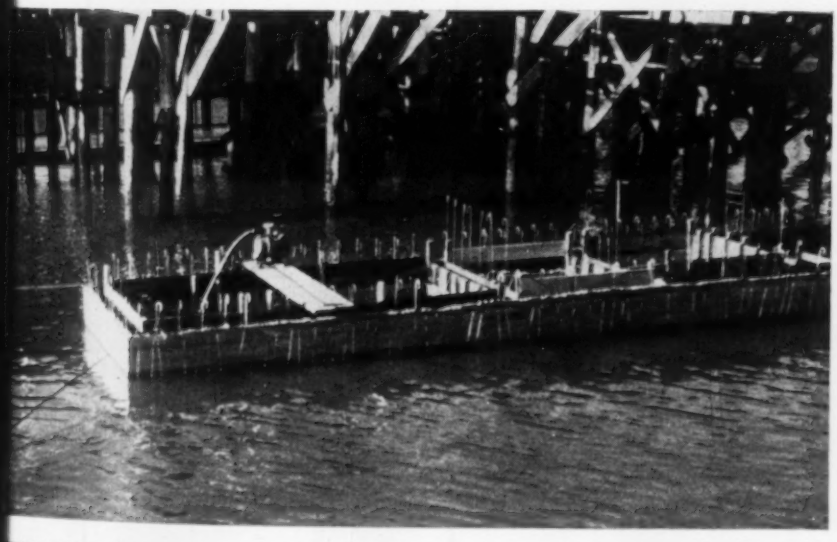
Long Piles Cast and Driven Without Difficulty

Casting and handling of precast concrete piles up to 105 ft in length presented no unusual problems. In driving these long piles, it was necessary to pick them up outside the leads, move them into position, lower them into the mud, and then move the driver forward to place the hammer on top of the pile. A derrick with special leads was also used to drive some of the piles which were inaccessible to the driver. Both a No. 0 Vulcan (single-acting) and a No. 80-C Super Vulcan (double-acting) were used to drive the piles.

Brace piles consisted of untreated timber piles driven butt down with a No. 2 Vulcan hammer. These wood piles were selected for large tips and slight taper. After they were driven, precast concrete jackets were set over them and driven until well into the mud. A rope grommet and sheet metal plate were used to seal the bottom during driving. The jacket was sealed with grout through a small tremie pipe and the water pumped out. The jacket was then filled with concrete to the top.

These jackets were cast on wood soffits in the casting yard. They were 22 in. square with a 16-in.-dia hole, and varied from 30 to 65 ft in length. Outside forms were of steel and were similar to the pile forms. Inside forms were collapsible steel tubes invented by A. E. Troiel. After the inside core was withdrawn, the inside was kept damp until cured. The outside surfaces were cured with membrane curing compound. The soffits for the jackets were so designed that wire-rope slings could be threaded under the jackets at close intervals. The jackets were picked up and loaded by means of these slings.

The concrete caps were formed in place because it had been anticipated that, owing to the many pile snags and obstructions on the bottom, piles



RECAST CONCRETE SUBMERGED TRANSFORMER VAULTS, 52 ft 6 in. long, 10 ft wide nd 8 ft high, are floated into position and placed on piles under pier deck of two large einforced concrete piers at San Francisco Naval Shipyard. Economical construction of ry, waterproof transformer vaults and saving of several months' time are result of precasting.

PIPEWAY AND BARGEWAY some 1,500 ft long, for carrying pipelines and servicing barges, is constructed behind wharf at Point Richmond. Pipeway consists primarily of longitudinal and transverse beams with spans up to 24 ft. Precast construction proved more economical than original cast-in-place design.

could not be driven with accuracy. Actually, little difficulty was encountered in driving to exact position.

Precast deck slabs were cast on the flat slab at the casting yard. The side forms were very simple and were held to the casting slab by embedded anchor bolts. Slabs were lifted in seven days and stored in stacks up to ten high. They were given a rough finish by drawing stable brooms across the surface. Curing was done with a membrane compound. The slabs were handled with wire-rope slings hooked to the projecting reinforcing steel at eight or more pick-up points, and were loaded on barges in stacks, with as many as 100 to a barge load.

The slabs were set with a derrick and rested on a fiber strip cemented to the cap, an arrangement which insured even bearing. As many as 70 slabs were set in one 8-hour day. After setting, the top surface and the reinforcing steel were lightly sand-blasted to remove any membrane curing compound remaining. The slabs were blown clean and wetted down, and the top 5-in. deck of concrete was poured.

Pouring Gantry Installed

To facilitate the pouring of precast concrete jackets, piles, and deck slabs at the casting yard, a pouring gantry was installed. This gantry had a gage or clear span of 105 ft and ran on parallel tracks inside and underneath the large handling gantry to enable concrete pouring to continue at the same time that finished products were being moved or loaded. At the side of the pouring gantry, ready-mix concrete trucks dumped into a hopper which was raised and dumped into smaller hoppers traveling back and forth across the gantry and discharging into the forms through elephant trunks. Vibrators were also suspended from the gantry.

One of the major problems confronted in building a structure over water, and especially a pier extending out from the shore, is the storage and distribution of form lumber, reinforcing steel, and other items. It has always been an expensive and difficult problem to get materials across the area just being prepared for a pour to a point beyond where forming has just been started. Experience on the repair wharf amply demonstrated the value of the precast method in simplifying this problem. The repair wharf was completed without difficulty of any sort developing in the erection of the precast members, and the construction of the main or T-head wharf was begun using the same design and methods.

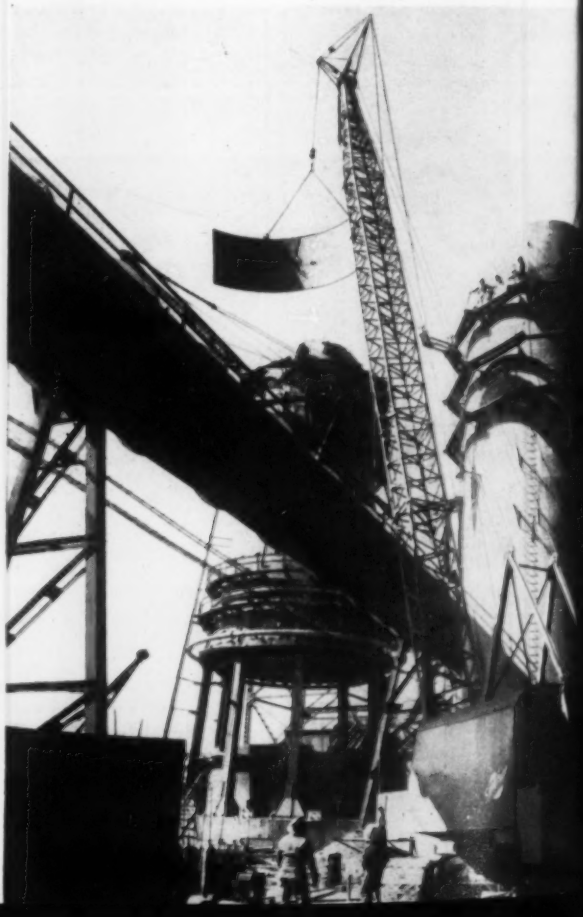
Movable Corners for Wharf

Because of strong tidal currents and a prevailing westerly wind, tankers and tugs with oil barges are frequently forced to warp around the corners of the wharf. To meet the problem of a strong yet yielding corner, the consulting engineer, M. Earl, designed a movable corner of precast concrete. Weighing 26 tons each corner rides on plates of bronze and steel. Heavy, electro-galvanized springs resist movement, and return the corner to position. Provision is made to lubricate the plates by means of oil grooves. Five of these corners

(*Continued on page 84*)

New Construction Increases Steel Production

BLAST FURNACE—one of world's largest—is part of U.S. Steel's construction and modernization program which has totaled $775 million since V-J Day. Two such furnaces are being completed at the South Chicago, Ill., Works of U.S. Steel's Carnegie-Illinois Steel Corp. These and other similar projects are increasing corporation's blast furnace capacity by one million tons a year. Despite higher costs, shortages of materials and labor, U. S. Steel reports more than 25 percent increase in productive capacity between January 1, 1940, and January 1, 1948, making possible record production of 28.6 million net tons of steel in year 1947.



Court Clarifies "Bona Fide Residence" for Income Tax Purposes

Ruling Gives Wide Travel Privileges to Engineers in Foreign Service

WITH INCREASING AMOUNTS of American funds being used to finance heavy construction in foreign lands, more American engineers are weighing the pros and cons of foreign assignments. Experience gained on some of the great engineering works now under way and in the blueprint stage will not only benefit the individual engineer but will add to this nation's reservoir of professional knowledge. In his article on federal income tax requirements, published in the October 1947 issue of CIVIL ENGINEERING, Edmund H. Lang, Assoc. M. ASCE, reminds U.S. engineers seeking foreign service that factors such as date of completion of job, risk of disease, inflated costs and temporary or permanent residence in a foreign country affect the amount of income tax that must be paid. A recent court action reported by Godfrey N. Nelson in The *New York Times* (June 27, 1948) clarifies what may be deemed to be a bona fide residence in a foreign country. Mr. Nelson's summary of the change in taxing procedure is presented here.

DISCUSSING FURTHER the exemption from income tax of United States citizens residing in foreign countries, it should be noted primarily that a citizen, regardless of his place of residence, within or without the United States, is generally taxable on all his income without regard to the place of its origin.

The exemption of earnings of citizens residing abroad derives its authority from specific statutory provision (Section 116 (a) of the Internal Revenue Code). Freedom from withholding income tax on income earned by a citizen in a foreign country, likewise, emanates from the statute (Section 1621 (a) 8 of the Code).

In order to justify the exclusion from taxable income of income earned abroad, the statute requires that such citizen shall be a bona fide resident of a foreign country during the entire taxable year. This does not mean that the citizen is required to have spent the entire year in the foreign country. He is permitted to absent himself from such country or countries on vacation, and on business trips to the United States according to reasonable requirements of his employment abroad.

Conditions of "Residence"

Except that a citizen must be a resident of a foreign country in good faith, the statute does not define "residence." The Senate Finance Committee indicated that the tests as to residence in a foreign country would be those generally applicable in determining whether an alien is a resident of the United States.

"An alien actually present in the United States, who is not a mere transient or sojourner, is a resident of the United States for purposes of the income tax." (Section 29.211-2 of Treasury Regulations 111.) The presumption is that he is not a transient unless he has a definite intention to leave promptly as soon as he has accomplished the purpose of his visit. It he has no definite intention as to the length of his stay, he is a resident. An alien whose stay in the United States is limited by the immigration laws to a definite period, however, is not generally a resident of the United States.

It has been held by the Circuit Court of Appeals, Fifth Circuit, that despite the fact that a United States citizen moved from place to place in a foreign country for a period of four years, he was not a mere "transient" or "sojourner," but was a bona fide resident; that although he "had no fixed home or settled place of abode" in the foreign country, he was, nevertheless, exempt from income tax. Here, however, the circumstances and the characteristics of the citizen's occupation were important considerations (Swenson v. Thomas, 164 Fed. 2d. 783, decided Dec. 4, 1947, reversing the United States District Court).

SECTION 116 (a)(1) of the Internal Revenue Code provides that an individual citizen of the United States, who establishes to the satisfaction of the Commissioner of Internal Revenue that he is a bona fide resident of a foreign country (or countries) throughout the entire taxable year, may exclude from gross income (income subject to federal taxation) amounts received during such year from sources outside the United States (except amounts paid by the United States or an agency thereof) as compensation for personal services performed by him.

There are four requirements which must be met if the taxpayer is to be allowed the benefits of Section 116(a)(1): (1) The income to be excluded must represent compensation for personal services performed outside the United States; (2) the income to be excluded must have been paid other than by the United States or an agency thereof; (3) the taxpayer must have been a bona fide resident of a foreign country (or countries) for the entire taxable year; and (4) he must satisfy the Commissioner of Internal Revenue as to the bona fides of his foreign residence.

Details of Case

The facts of the case, as stated in the decision, are that Swenson was born and always domiciled in Texas; that he graduated in 1935 at the University of Illinois; that since his graduation he has been engaged in geophysical work; that he first went abroad on such work in 1937; that in 1941 he entered into a contract with his employer for a period of three years, for a salary, a bonus and living expenses while outside the United States. He was sent to Colombia, South America, to prospect for oil, having charge of a crew of laborers often numbering 200 men. His time was mostly spent in the forests and jungles.

After Swenson had served three years without returning to the United States, he was asked, and consented, to extend his contract for another year. Thus, he lived in Colombia for a period of four years. "He expected all the time to return to the United States when the work was done, and in his application for passport stated he expected to return in three years." He paid income taxes while in Colombia, to that government. No income taxes had been required of him by the United States while he was in foreign service—not until the tax controversy arose.

The court concluded that notwithstanding the fact that this United States citizen established no fixed home in Colombia, or even a settled place of abode, his work requiring him to move from place to place, "it remains true that he was always living in Colombia, attending to his business there; and that, we think, constitutes residence there."

CONTRACTOR-BUILT OVERPASS, part of 3-mile haul road, enables large diesel-powered off-the-highway type bottom-dump trucks to cross main four-lane highway with fill for San Francisco International Airport. In moving nearly 17 million cu yd of dirt, more than two million highway crossings are made without serious accident. Final cost of haul road, including overpasses, underpasses and right-of-way, but excluding maintenance and subsequent damage suits, totals well over $750,000.

Mammoth Earthmoving Job Features San Francisco International Airport Construction

Foothills Furnish 9,500,000 Cu Yd of Fill for Bay Project

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Project Manager, Macco Corp. and
Morrison-Knudsen Co., Inc.

CAREFUL PLANNING and close coordination of operations enabled the author's firms to move dirt at the rate of 1,000,000 cu yd a month to expand existing Mills Field to what is now known as San Francisco International Airport by filling the shallow waters of San Francisco Bay. Although the contractor-owned hill from which the fill was obtained, was only three miles from the airport, the earthmoving operation involved the crossing of highways, a railroad, streetcar line, and numerous utility lines. Moving a total of 9,500,000 cu yd of dirt from the foothills to the bay in $3^1/_2$ years of high-speed production required the use of the most efficient equipment obtainable. The work was performed under two contracts as a "joint venture" of the Macco Corp. of Clearwater, Calif., and the Morrison-Knudsen Co., Inc., of Boise, Idaho, with the author as project manager. A paper on this subject was presented before the Construction Division at the ASCE Summer Convention in Seattle, Wash.

MANY MILLIONS OF YARDS of fill have been added over a ten-year period to enable the San Francisco International Airport, formerly known as Mill's Field, to take its rightful place among the world's great airfields. As early as 1937, one of the member firms of the "joint venture" which the writer represents had a contract to move 500,000 cu yd of fill to the airport from a specified borrow pit. In 1939 and 1940 the same firm had a contract to move 1,300,000 cu yd of fill from a contractor-furnished borrow pit to the airport.

The contractors knew that upon completion of the latter job, the airport would still require many million cubic yards of material to enable it to fulfill its purpose. The company for which the writer worked at that time authorized him to spend what spare time he had in scouting for available sources of material and in locating possible haul routes to the field. This paper is based chiefly on two contracts which extended with only minor interruptions over a period of $3^1/_2$ years, both serving the same general purpose of enlarging the airport.

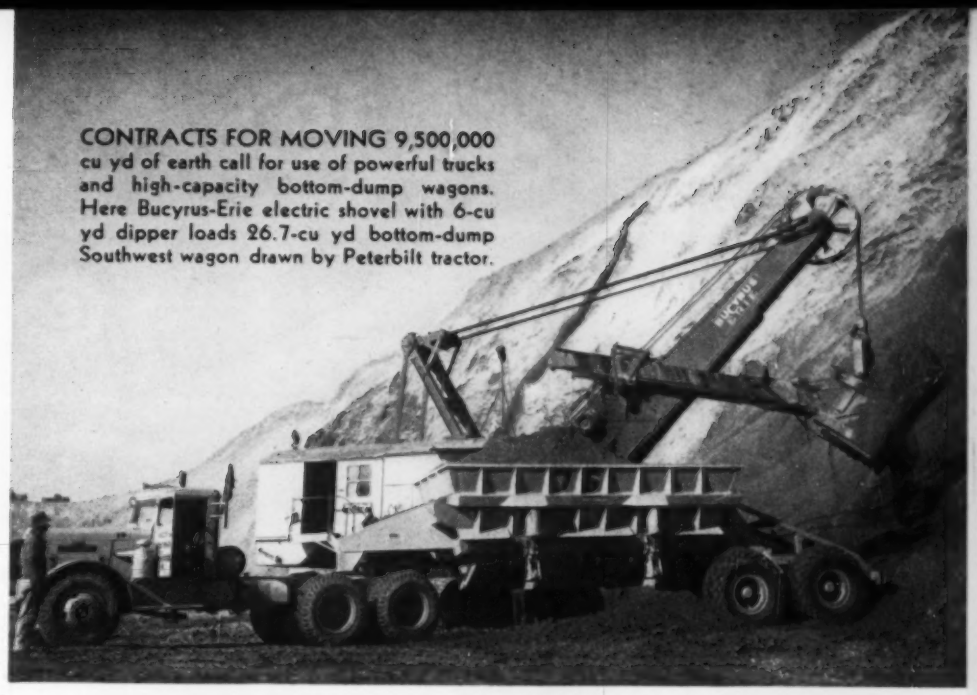
Specifications for Fill

In 1944, the U.S. Army Engineers called for bids for the placing of 2,500,000 cu yd of imported fill on Mill's Field from a contractor-furnished borrow pit. This material had to meet the following specifications:

1. A California Bearing Ratio of 20
2. A maximum size of 4 in.
3. Compaction to 95 percent by the Modified Proctor Test under the runways and 90 percent in the shoulder areas

One of the contracting firms had located, and taken an option to buy, a hill that met these specifications in an unsuspected location only three miles from the fill site. However, a haul road would have to cross two main four-lane California state highways, the main double-track line of the Southern Pacific Railroad, a parallel interurban streetcar line, and numerous utility lines, both underground and overhead. The firm had sunk three diamond drill holes which showed that more than the required amount of specified fill material could be obtained from the site, and had run one or more surveys of possible haul-road locations before the opening of bids. Having obtained options on material for constructing overhead crossings of the highways, railroad and interurban line, the firm was ready for the bid.

It was customary during the war years when equipment was scarce, supervisory personnel at a premium, and manpower available only to jobs that provided the steadiest employ-



CONTRACTS FOR MOVING 9,500,000 cu yd of earth call for use of powerful trucks and high-capacity bottom-dump wagons. Here Bucyrus-Erie electric shovel with 6-cu yd dipper loads 26.7-cu yd bottom-dump Southwest wagon drawn by Peterbilt tractor.

ment with the greatest amount of overtime, to form "joint ventures" on all large contracts. The joint venture of Macco Corp. and Morrison-Knudsen Co., Inc., was formed for the San Francisco Airport contract and was the low bidder. Then started the race against time, for the specifications provided that "after a 30-day preparation period, fill shall be delivered at the rate of 416,000 cu yd each 30-day period and should the contractors fail to meet with this delivery schedule, they are subject to a 10 percent per cu yd penalty." Within a week's time, right-of-way contracts had to be negotiated with the following parties:

1. The City and County of San Francisco, for permission to build 3,800 ft of roadway through lands owned by them but leased to four tenant farmers and planted to crops, and to agree upon the amount of loss each of the four farmers would suffer by reason of the haul-road construction.

2. The State of California, Division of Highways, for permission to construct two steel crossings over the two main highways.

3. The Southern Pacific Railroad, for permission to construct a steel crossing over its main peninsula double-track line.

4. The Market Street Railroad, for permission to extend the steel crossing erected over the Southern Pacific Lines over its double-track interurban lines.

5. The City and County of San Francisco Water Department, for permission to construct footings (for one of the overpasses) adjacent to and under its 44- and 54-in. main aqueducts to San Francisco.

6. The Pacific Gas and Electric Co., for the raising of its 60,000-v transmission line, and other distribution lines, so that adequate clearance for traffic on the overpasses would be provided.

7. The Pacific Telephone and Telegraph Co., for the revamping of its main local and long-distance cables along the state highway right-of-way.

8. Several individual property owners, most of them corporations, for permission to construct a haul road across their properties. At the same time, it was necessary for the contractors to acquire, by outright purchase, two subdivided city blocks consisting of 34 lots.

These negotiations were successfully carried out by the writer and his assistants in spite of the short time available. Speed was the main requisite and cost was secondary. The right-of-way was paid for dearly. The contractors agreed to assume any and all costs of moving utilities and their eventual restoration, and in certain instances put up a deposit to cover their restoration or paid the estimated cost in advance.

Construction of Haul Road. At the time that the agreements were being negotiated, actual construction of the haul road and overpass structures was going ahead on the basis of two 10-hour shifts daily. The main items involved in haul-road construction were as follows:

1.	Excavation . . .	345,000 cu yd
2.	Timber in overpass ramps . .	900 million fbm
3.	Steel in overpass structures . .	540 tons
4.	Rock base and paving on road	30,000 tons

The foregoing paragraphs give a rough idea of the contractor's "getting started troubles" on the job. On the ordinary contract such matters are arranged by the contracting agency months in advance of the letting of the contract.

Completion of 1944 Contract. In addition to the "getting started" right-of-way troubles, the contracting firms had to assemble loading, hauling and spreading equipment as well as combat the rubber-tire shortage and other wartime restrictions. The first contract for 2,500,000 cu yd of fill was finished on schedule in December 1944 without penalty.

AT END OF EACH SHIFT trucks pull into fuel pit where four units can be refueled at one time and where 85 large vehicles can be serviced in half-hour period between shifts. Each driver is on duty until truck is fueled, oil checked, radiator filled and vehicle parked for next shift or for night grease crew.

FILL MATERIAL FOR SAN FRANCISCO INTERNATIONAL AIRPORT is windrowed and spread in 8-in. lifts and compacted according to Modified Proctor Test to 95 percent under runways and to 90 percent in shoulder areas.

Thereupon equipment and personnel were shipped to other jobs.

Start of 1946 Contract. In April 1946, bids were opened by the City and County of San Francisco for 6,000,000 cu yd of additional fill and the same combination of firms was again the low bidder. The haul road had been kept intact and right-of-way agreements had been renewed so that the contractors did not have to make these preparations again.

Drilling and Shooting. The material in the borrow pit consisted of a water-deposited sand so fine that 45 to 60 percent of it would go through a 200-mesh sieve but in its natural state the material had been partially solidified so that it was more economical to shoot it than to have the shovels gnaw it. However, a series of earthquake faults in the vicinity of the borrow area transmitted the shocks a considerable distance with the result that residents of nearby communities complained bitterly and loudly to the County Board of Supervisors. Finally, as a matter of public policy, the contractors decided to climb to a higher level and loosen the material with dozers and rippers.

Loading. The material was loaded on trucks with either 120B Bucyrus-Erie electric shovels with 6-cu yd buckets or Northwest 80D s with $2^1/_2$-cu yd buckets. There were three electric shovels and four diesels which all together produced 2,500 cu yd per hour, or 40,000 cu yd per day in two eight-hour shifts.

Hauling Equipment. Upon the award of the 6,000,000-cu yd contract, the contractors ordered 30 Peterbilt trucks with Southwest bottom-dump trailers of 30-cu yd capacity. The trucks were a new development pioneered just before the war started, but held up by wartime regulations. Speedy delivery was promised, but the first wave of strikes prevented delivery until the job was 90 percent completed. In the meantime 20 war-surplus White

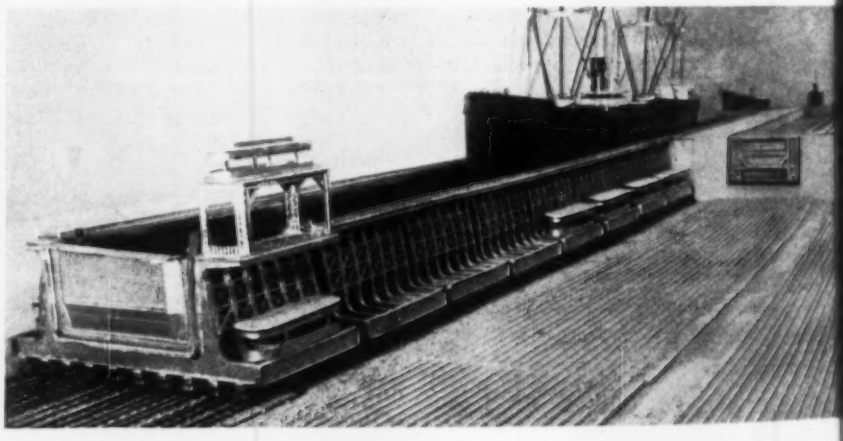
(*Continued on page 84*)

Scheme Utilizes Rails to Transport Ocean Liners Across Tehuantepec Isthmus

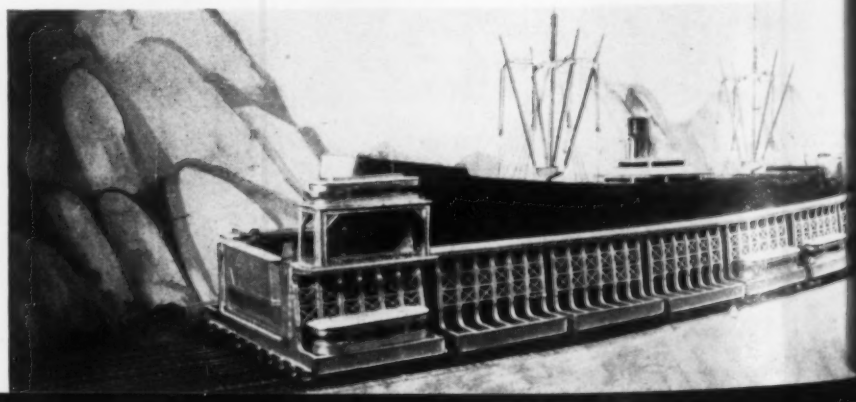
FOR MORE THAN A HUNDRED YEARS American engineers have been investigating means of connecting the Atlantic and Pacific Oceans through or over Mexico's Isthmus of Tehuantepec. Because of the prohibitive expense of a canal through the isthmus, a railroad specially designed to transport sea-going vessels is proposed by M. C. Rolland, Mexican engineer, in the publication, *Transporté de Buques por el Istmo de Tehuantepec* (Mexico, May 1948).

Fantastic as Mr. Rolland's proposal may appear at first glance, it has been given credence by eminent U.S. engineers. A similar scheme was suggested by Capt. James B. Eads, M. ASCE, in 1880, although he envisioned boats weighing up to 4,000 tons, transported by steam locomotives, whereas the present proposal is for vessels up to 10,000 tons, moved by diesel-electric power.

Estimated to cost $1,200,000,000, the overland shipway would connect two ocean ports, Salina Cruz on the Pacific side, and Puerto Mexico on the Gulf of Mexico side, and would traverse a more healthful region than the present Panama Canal. A symposium on the Panama Canal as a sea-level project appeared in the ASCE PROCEEDINGS for April 1948.



PROPOSED PLAN ENVISAGES huge water-filled floating-drydock type of structure riding on ten sets of parallel tracks for distance of about 155 miles across Isthmus of Tehuantepec. Vessels up to 150 meters long (492 ft), 18 meters wide (59 ft) and 20 meters high (66 ft) could be moved by diesel-electric power at rate of about 18 mph, making trip across isthmus in period of 9 hours and 40 minutes, according to Mexican engineer M. C. Rolland.



Engineers' Notebook

Parking Facilities in Existing Buildings Offer Solution to Downtown Parking Problem

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TRAFFIC ENGINEERS have suggested many methods for solving the problem of providing adequate parking facilities in congested downtown areas. These suggestions include the clearing of dilapidated city blocks for use as parking lots, providing of large open lots in outlying areas to discourage driving into congested sections, and the building of costly subsurface or elevator garages. All such schemes have certain disadvantages, ranging from the cost of construction to inconvenience to the parker.

Open or covered lots, where cars are parked in close formation with little freedom of movement, have many disadvantages plus the facts that comparatively few downtown lots are available, and land values usually dictate the use of such lots for more remunerative purposes. Any solution to the downtown parking problem must necessarily involve considerable expense; therefore any practical proposal which may cut costs and promise some satisfactory result should be worth considering.

Reconstruction of Ground-Floor Areas

In principle, the method proposed here is to reconstruct the entire ground floor or basement areas of many existing downtown buildings,

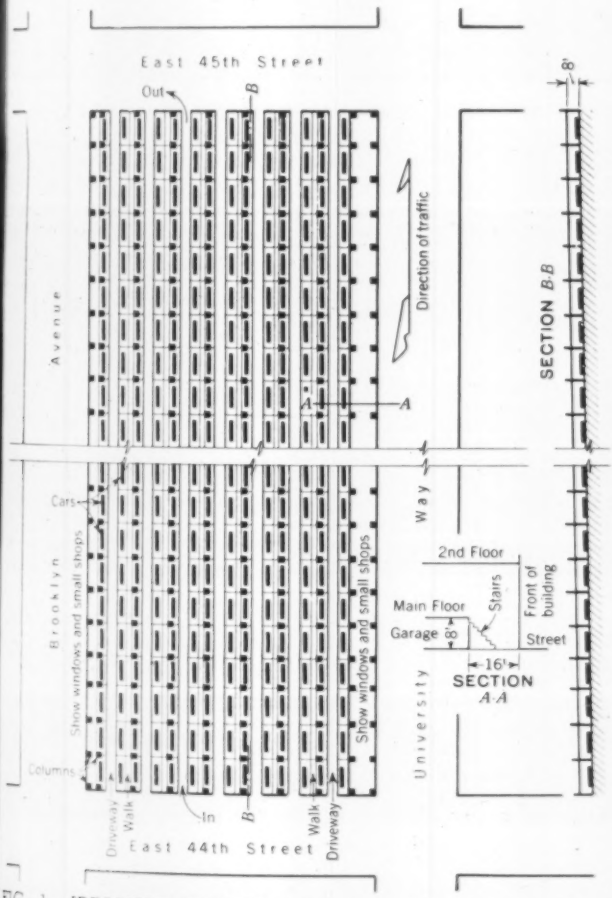

FIG. 1. IDEALIZED SKETCH shows ground-floor-level parking system for existing buildings in crowded downtown areas. Single-lane parallel driveways extending full length of city block provide access to parking areas.

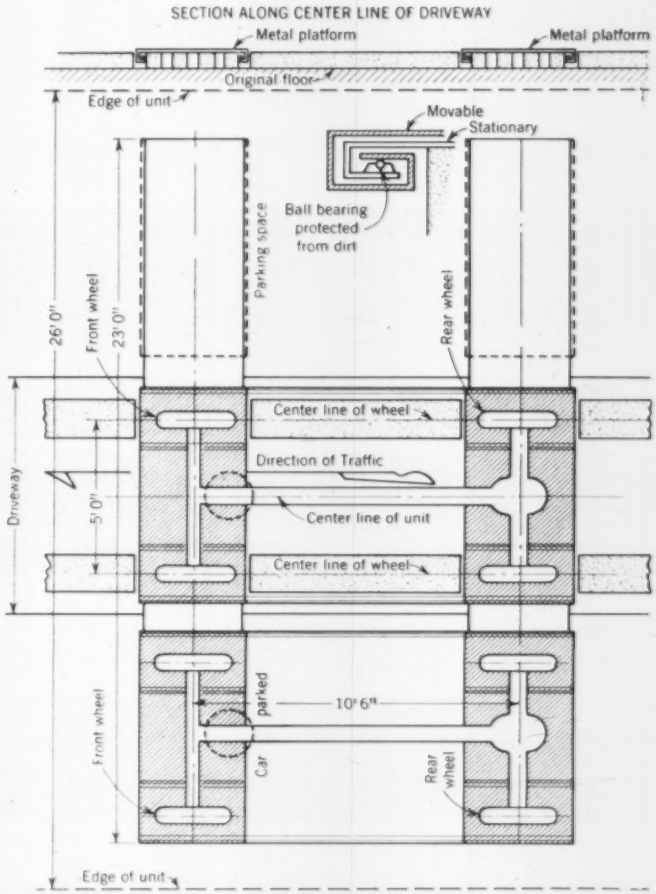

FIG. 2. ROLLING PLATFORM provides simple method for moving cars laterally from series of parallel driveways to parking lanes shown in Fig. 1. System permits efficient use of space between building columns.

using the space as parking accommodation for automobiles. This utilization of space would be less costly than new construction under present high costs and would solve the parking problem in the most congested areas. Details of the scheme are shown in Fig. 1. A series of one-way parallel lanes extending, if practicable, through an entire city block would require about 8 ft of headroom. Many street-level floors of our modern buildings can be elevated 8 ft or more to provide clearance for the parking lanes without reducing ceiling heights too drastically. An arcade wide enough for a public passageway and a series of small shops or display windows could be provided along the available sides of the building, allowing entrance by stairway or escalator to the main floor above the parking lot.

Basement-level parking lanes reached by ramps or similar alternate arrangements may prove to be more economical, depending on the architecture of the buildings involved and other factors dictated by local conditions. The fundamental idea remains the same, however—long parallel driveways through existing buildings, extending the entire length of the city block where possible. Revenues from parking fees should make the parking facilities an attractive financial enterprise to property owners.

Advantages of Proposed Plan

It would seem good business to use and remodel the already acquired space in these properties rather than purchase new sites within or without a specific area and construct entirely new buildings for parking purposes. The proposed plan would also ensure a more equable distribution of parking accommodations over the business sections.

A rolling platform for moving cars laterally from driveway to parking space would permit maximum utilization of available space, free movement of cars being prohibited because of building columns. Details of such a platform are shown in Fig. 2.

Aside from convenience to the individual car owner and reduction of wear and tear on the car, the points in favor of the suggested parking system may be summed up as follows. It will:

1. Attract business now diverted by lack of parking facilities.
2. Leave business streets free for moving traffic.
3. Help reduce accidents.
4. Yield substantial revenue to property owners.

While millions of dollars are spent on highways leading to and from our cities it is regrettable that the motorist arriving at his destination should find the parking problem in such chaotic condition. Provision of adequate downtown parking facilities in our large cities has become a major planning problem.

Pipe Sizes Reflect Engineering Knowledge of Ancient Romans

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CONSTRUCTION SKILL of a high order was exhibited by the ancient Romans in the building of their aqueducts, baths and reservoirs. This fact is well known, but not so well known is the fact that their waterworks were fed by pipes graduated in size in accordance with a system remarkably similar to that now in use in the United States.

In Clemens Herschel's scholarly translation of Frontinus' book on the water supply of ancient Rome are data from which can be constructed a table of sizes of pipe fittings actually employed for connections to aqueducts and reservoirs about 97 A.D. Frontinus says that some of the sizes he lists were "not in use." From this it is assumed that the sizes that were in use were those which experience had shown to be suitable for the needs of water supply engineering as practiced in Rome in the first century of the Christian era. How closely these size gradations conform to those employed at the present time is shown in Fig. 1.

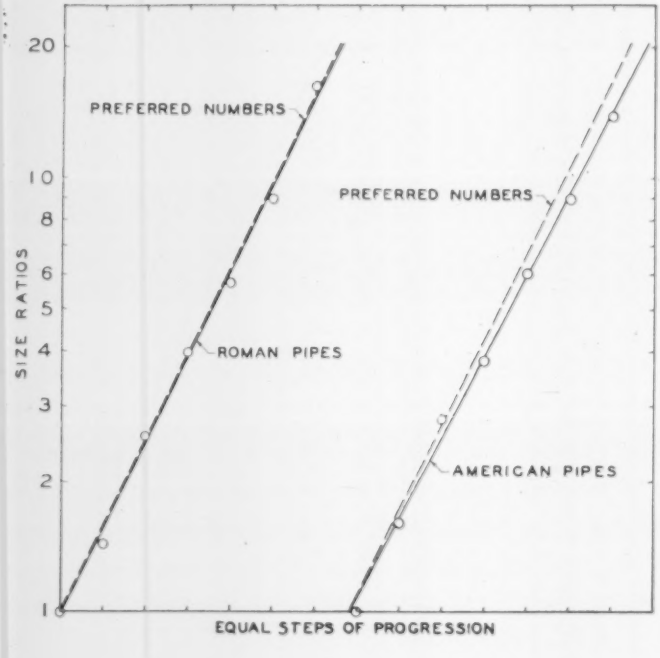

FIG. 1. STANDARD PIPE SIZES of ancient Romans conform with those in use today. Left-hand unbroken line in graph represents first seven Roman sizes listed in Table I, and right-hand line is for standard American sizes from $^3/_4$ in. to 3 in. Two broken lines, which are plotted from same basis and represent "5-series" of American Standard preferred numbers, show how closely both systems of pipe sizes correspond with principles of geometrical progression. (See bibliographical reference No. 3 at end of article.)

Two Systems of Pipe Sizes

Two systems were used for designating pipe sizes according to Frontinus, one for pipes up to about 3.66-in. diameter, with irregular increments of capacity between sizes, and the other for the larger sizes, with regular increments of capacity between sizes. The whole range covered sizes from $^{29}/_{32}$ in. to about 9 in. in diameter. Up to what the Romans called the "20-pipe" size, pipes were designated according to their inside diameters in quarter digits. (The digit was $^1/_{16}$ of a Roman foot, or about $^7/_{10}$ in. in our terms.) Thus the "5-pipe" was 5 quarter digits, or $1^1/_4$ whole digits, in diameter. Simi-

larly the "20-pipe" was 20 quarter digits, or 5 whole digits, in diameter. Above the 20-pipe size the designations represented the pipe area in square digits.

It so happened that in the case of the 20-pipe, the "20" represented approximately the diameter in quarter digits and the area in square digits, making this size a suitable point of transition between the two systems of designating sizes.

Roman Measurement of Pipe Capacities

Pipe capacities were measured in *quinariae*, one of which was equivalent to the capacity of a pipe 5 quarter digits in diameter, the base size. Other sizes were graduated so as to give a suitable range of capacities to meet practical needs, as shown in Table I. Note how the system changes at the 20-pipe size.

The first seven sizes of Roman pipe listed in Table I are plotted as the left-hand unbroken line in Fig. 1. This curve, plotted as a mathematical progression on a logarithmic vertical scale, is a straight line fitted to the points by the method of least squares. Obviously, for all practical purposes the series is a geometrical progression and hence in keeping with modern theories of preferred numbers.[1,2] The two broken lines in Fig. 1, which are parallel, are plotted from the same origin and represent the 5-series of American Standard preferred numbers,[3] where each number bears to the preceding one the ratio of $\sqrt[5]{10}$ to 1. The left-hand broken line is in fact so nearly identical with the unbroken line for Roman pipe sizes that the graph exaggerates the difference between them. The fifth root of 10 is 1.5849, whereas the figure derived from the slope for Roman pipe sizes is 1.5823. Evidently the men responsible for the water supply of ancient Rome arrived, some 1,900 years ago, at a very modern conception of a suitable range of pipe sizes.

The unbroken line to the right in Fig. 1 represents the sectional areas of American steel pipe (Schedule 40) for approximately the same range of sizes—$^3/_4$ in. to 3 in., inclusive—plotted in the same way as the line for Roman pipe. This line has a slope giving a ratio of 1.540 to 1 between each size and the preceding one—not quite as great as the fifth root of 10.

Other Similarities Between Ancient and Modern Sizes

Of interest is the tendency, both in ancient Rome and in modern times, to discard sizes that fall too far away from the line of geometrical progression. For instance, the $3^1/_2$-in. size of American pipe would fall substantially to the right of the line, showing too small an increment in size to fit the progression. And this is a size of steel or wrought-iron pipe infrequently used. The same is true of the "7-pipe" of the Roman system, one of the sizes which Frontinus says was "not in use." Its insertion in the graph would make a sharp jog in the plotted line.

No less interesting is the fact that the upper limit of geometrical progression for pipe sizes is about the same for American as for ancient Roman pipes. At about the 3-in. or $3^1/_2$-in. size, pipe areas in both systems depart from the original geometrical progression. The Roman sizes above the 20-pipe are in exact arithmetical progression. American pipes from 4 to 10 in. in diameter have areas that fall in geometrical progression (on another line) but the $3^1/_2$-in. size does not fit either line. If this size is discarded on the ground that it is little used, a straight line fitted to the whole series of American sizes from $^3/_4$ in. to 10 in. will have a slope of 1.578, and will be almost identical in both slope and origin with the line for the smaller Roman sizes. There may be something basic about this progression with a ratio approximating the fifth root of 10.

Now that modular design and coordination have come in for such favorable consideration, it is worth noting that the water pipe fittings here discussed were known to the Romans as "modules" (Latin *moduli*) and actually served as metering devices on the basis of which water rights were granted.

Who can say how long a time was required, or what process was employed, in arriving at the array of pipe sizes used by the Romans to supply water for domestic purposes and for their magnificent public baths and fountains? In the first century A.D., more than a thousand years before the invention of decimal fractions, the number 3.65 (simple enough to us) had to be written: 3 plus $^7/_{12}$ plus $^1/_{24}$ plus $^1/_{48}$. That a series of sizes arranged in an order corresponding to the modern concept of preferred numbers, based on a root of 10, could be developed under the handicap of such a system of numeration seems incredible. Nevertheless it was done.

How Were Ancient Pipe Sizes Developed?

Frontinus is silent as to the method used in developing the pipe sizes he lists. He states merely that they were established by Augustus Caesar and, in another passage, that they were "set down and verified in the records of our most puissant and patriotic emperor" (Trajan). It is hard to put oneself in the place of an engineer of those distant days. He had no slide rule, no logarithms, no decimal fractions and yet he solved a complicated problem in an essentially modern way.

TABLE I. STANDARD PIPE SIZES OF THE ANCIENT ROMANS COMPARED WITH THOSE IN USE TODAY

Roman Pipe					Nearest Modern Equivalents		
Pipe Number	Capacity in Quinariae	Increment of Capacity	Diameter in Digits	Diameter in Inches	Diameter in Inches	Relative Sectional Area*	Increment of Area
5	1.00		1.25	0.91	($^3/_4$) 0.82	1.00	...
6	1.44	0.44	1.50	1.09	(1) 1.05	1.62	0.62
8	2.56	1.12	2.00	1.45	($1^1/_4$) 1.38	2.81	1.19
10	4.00	1.46	2.50	1.81	($1^1/_2$) 1.61	3.82	1.01
12	5.76	1.76	3.00	2.17	(2) 2.07	6.06	2.24
15	9.00	3.24	3.75	2.72	($2^1/_2$) 2.47	9.00	2.94
...	...	...	...	...	(3) 3.07	13.88	4.88
20	16.29	7.29	5.00	3.62	($3^1/_2$) 3.55	18.55	4.67
30	24.43	8.14	6.18	4.48	(4) 4.03	23.88	5.33
40	32.58	8.15	7.13	5.17	(5) 5.05	37.52	13.64
50	40.73	8.15	7.98	5.78	... ...	...	...
...	...	...	...	...	(6) 6.06	54.20	16.68
60	48.87	8.14	8.74	6.34	... ...	...	...
70	57.02	8.15	9.44	6.84	... ...	...	...
80	65.17	8.15	10.09	7.32	... ...	...	...
90	73.31	8.14	10.70	7.76	... ...	...	...
100	81.45	8.14	11.28	8.18	(8) 7.98	93.83	39.63
120	97.75	16.30	12.35	8.95	... ...	...	...
...	...	...	...	...	(10) 10.02	147.95	54.12

* Taking $^3/_4$ in. as the base size.

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[2] "Possibilities of Preferred Numbers in Civil Engineering," Sydney Wilmot, M. ASCE, *Engineering and Contracting*, February 25, 1925.

[3] American Standard Preferred Numbers, Z17.1-1936, American Standards Association.

... THE READERS Write

Applies Newton's Formula in Solving Cubic Equations

TO THE EDITOR: The February issue carried an article by William R. Davis under the intriguing title, "Graph Solves Cubic Equation When Cardan's Formula Fails." It should be made clear that Cardan's solution is a method of giving an "exact" solution of a cubic in terms of square roots, and that it fills an entirely different need from a graphic method. If we want a decimal approximation to a root, to any specified number of places, Cardan's solution is seldom useful; the classical Horner's and Newton's methods are nearly always easier. Newton's method, at least, is also easier than the solution suggested by Mr. Davis.

Newton's method will solve any equation of the type $f(x) = 0$. Let $f(x) = y$, and find an approximate root x_1. Usually the approximation need not be very accurate. By substituting x_1 in the equation, the value y_1 is obtained. If y_1 is zero, we have the solution. If not, a better approximation may be obtained as follows:

Compute the derivative $y' = dy/dx$, and substitute x_1, for x. This gives y_1', the value of dy/dx when x has the value of x_1. If we let x_0 be the root, the slope of the curve is $y_1' = y_1/(x_1 - x_0)$, to the approximation that the curve is a straight line in this short stretch. Solving, $x_0 = x_1 - y_1/y_1'$. That is, the ratio of y_1 to y_1', with sign changed, is the correction to the approximate root x_1. This process may be repeated as many times as seem necessary, at each stage taking the computations to as many decimal places as seem likely to be significant. The accompanying table shows this computation by Newton's method for the equation used by Mr. Davis, that is, $x^3 - 11.52x + 9.61 = 0$. Then, $y = x^3 - 11.52x + 9.61$; and $y' = 3x^2 - 11.52$. As a rough approximation, let $x_1 = 1$.

It may be noted that the equations given by Mr. Davis for the second and third approximations are simply Newton's formula as applied to this particular type of equation, but made much more tedious by giving the next approximation itself instead of the correction.

The letter in the June issue by N. A. Carle raises the objection that Mr. Davis' solution is "too much involved with the intermediate calculations." However, Mr. Carle's method is much more tedious than Newton's, more nearly resembling Horner's method, although it lacks the short-cuts for which the latter is noted.

H. HERBERT HOWE
Washington, D.C.

TABLE I. SOLUTION BY NEWTON'S METHOD

x	x^3	$-11.52x$	y	x^2	$3x^2$	y'	$-y/y'$
1.0	1.0	−11.52	−0.91	1.0	3.0	−8.52	−0.1
0.9	0.729	−10.368	−0.029	+0.81	2.43	−9.09	−0.0032
0.8968	0.721251615	−10.331136	0.000115615	0.804	2.412	−9.11	+0.0000127
0.8968127							

NOTE: The terms of y' need not be taken any more accurately than here indicated. The squares and cubes were taken from Barlow's tables; the division was done on a sliderule. Thus, in a few minutes the solution was obtained correct to 7 decimal places. To go further expeditiously would require the use of a computing machine.

Structural Steel Designer for Wood Stacker Named

DEAR SIR: The caption accompanying the photograph of the suspension-bridge-type wood stacker conveyor, on page 76 of the June issue, states that it was designed and built by the Rust Engineering Co. The cylindrical concrete piers were designed and built by Rust, and the structural steel and cables in the trusses, towers and anchorages were designed and furnished by John A. Roebling's Sons Co., of Trenton, N. J. The material supplied by the Roebling Co. was erected by the field force of the Rust Engineering Co. under the supervision of a Roebling engineer.

H. KENT PRESTON, Assoc. M. ASCE
Trenton, N.J.

Work of Highway Division Committee Acknowledged

TO THE EDITOR: In the foreword to my article, "Accelerated Highway Program Calls for New Design and Construction Techniques," in the June issue, credit for my basic sources of information is very properly given to the ASCE Highway Division Committee on Developments in Highway Engineering and Construction. However, since this particular committee was made up of members who individually and collectively contributed equally to each subject treated in the committee report, it seems to me only proper that they be acknowledged as contributors of the basic information and ideas expressed in my article.

Members of the Committee on Developments in Highway Engineering and Construction are: Day Okes, chairman, H. E. Hilts, Frank A. Nikirk, H. W. Richardson, George M. Shepard, and William N. Carey, Jr., secretary.

DAY OKES, Assoc. M. ASCE
St. Paul, Minn.

Names Designers of Hydroelectric Projects

DEAR SIR: Reference is made to the article by Colonel Pettit, entitled "Federal Government Plays Important Role in Development of Hydroelectric Energy," which appeared in the June 1948 issue. The captions for the pictures of the Whitney Dam, Possum Kingdom Dam and the Twin City Dam all referred to the Ambursen Engineering Corp. as the designers.

I should like to give additional information on the designers of the other projects pictured. The Norfork Powerhouse and the Fort Peck Powerhouse and Surge Tanks were designed by the Harza Engineering Co. The St. Mary's Powerhouse was designed by Erik Floor and Associates. As far as the writer is aware, the U.S. Engineers did all of the design work for the Bonneville and Dennison projects.

E. MONTFORD FUCIK, Assoc. M. ASCE
Harza Engineering Co.
Chicago, Ill.

SOCIETY NEWS

Society's Economic Status Analyzed

Annual Address of the President Delivered at Seattle Convention

R. E. DOUGHERTY, PRESIDENT ASCE
Vice-President, New York Central System, New York, N.Y.

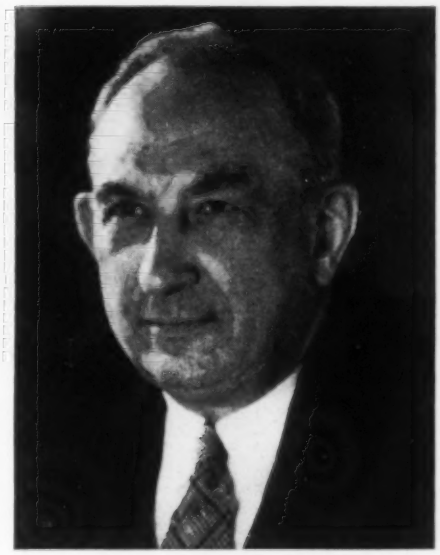
"THE MOST IMPORTANT problem before us is financial," President R. E. Dougherty declared in his Annual Address at the opening session of the ASCE Summer Convention in Seattle, Wash., July 21.

Discussing the proposed constitutional amendments for increasing dues of Members, Associate Members, and Affiliates $5.00 per year and Juniors $2.50 per year, President Dougherty said:

The dues of the Society were fixed in accordance with the present constitutional provisions in 1921. There is no need to expatiate on the changing world that has since evolved, with its expansion of problems and the decrease in the value of the dollar. In recent years your various Boards, in order to meet the increasing obligations and requirements of the Society, passed deficit budgets and based their judgment primarily on the cash position. This procedure could not be followed indefinitely, and the 1947 Board endeavored to persuade the Society to secure additional revenue by amendments authorizing an increase in dues, and failing in that effort wisely decided to balance its budget in any event. This caused serious curtailment in many activities, including the Technical Divisions and Committees, the Local Sections and their ramifications, and the Juniors and Student Chapters, the publications, already reduced beyond the satisfaction of many members preparing papers—in fact, a general all-around reduction in the efficiency of our functioning."

Estimating an increase of $85,000 in revenue through passage of the amendment increasing dues, and an increase of $67,000 if both the amendment increasing dues and the amendment equalizing dues in District 1 are adopted, Mr. Dougherty pointed out that "in either event, the immediate financial problem would be solved and the functioning of the Society restored substantially to the status prior to the reductions of the budget adopted in 1947." He also declared:

"The question has been raised as to what would happen if these amendments were not passed. I, for one, dislike to think of any further loss of efficiency in our functioning, but that is just exactly what it would mean. The Board has reached no conclusion as to just what form this further curtailment might take, but the Budget Committee thinks that it might mean an additional cut of $25,000. Various suggestions have been considered as to the form of further reductions, but I am sufficiently optimistic and confident to believe that that unfortunate contingency will not prevail."



R. E. Dougherty, President of ASCE

Mr. Dougherty paid tribute "To the careful and efficient work of the Budget Committee," consisting of George Burpee, chairman, Roy Crum, and Irving Huie.

Pointing out that "the question has also been raised as to certain functions of the Society being outside the limits of technical activities and beyond the scope of the constitution and its original purpose," Mr. Dougherty said: "I disagree emphatically with that idea, and let me quote the following from the Constitution:

'*Article I*:

3. The objects of the Society shall be the advancement of the sciences of engineering and architecture in their several branches, the professional improvement of its members, the encouragement of intercourse between men of practical science, and the establishment of a central point of reference and union for its members.' "

Continuing, President Dougherty declared:

"The Society is facing a different world from that of the founding fathers, the great problems of the world today are in economics, public and human relations, and the Society should take its proper place in these considerations.

"I have endeavored to analyze the economies that might be effected if we were to be confined entirely to technical activities, which certainly should be considered as improving the functioning of the Society with its Local Sections, Juniors and Student Chapters, and have reached the conclusion that a large proportion of that which many call professional activity involves functioning on the executive level for both the Board and the staff. It is difficult to place a finger on any material saving that could be accomplished by even a literal compliance with that suggestion. In addition, and on the minus side, it certainly would entail a tremendous loss of prestige."

In any consideration of the problems of the Society, Mr. Dougherty stated, the importance of the work of the Student Chapters must be emphasized. He pointed out that these groups, "now numbering 125, with a total membership of approximately 8,600, originated in 1920 only one year before the dues were last raised. Similarly," he said, "an increased interest in the Juniors is another distinct manifestation of progress as compared with the older days. In 1921, there were 500 Juniors out of a total membership of 10,000. In 1948, there are 7,250 out of a total membership of 23,600." Asserting that the importance of such activities cannot be overestimated, Mr. Dougherty recommended that Local Sections give careful consideration to the advisability of placing a Junior on their boards.

Actions of Board of Direction, ASCE Annual Convention

Seattle, Wash., July 19 and 20

EJC and ASCE Constitution

THE BOARD APPROVED the new constitution for Engineers Joint Council and received from the ASCE Committee on Revision of Constitution and By-Laws a draft of a completely new constitution for the Society.

Local Sections Constitutions

The constitutions of two new Local Sections, Southern Idaho and Brazil, were approved as was an amendment to the constitution of the Wyoming Section.

Fresno Conference Commended

The regional meeting of Sections held in Fresno, California, in April 1948 was commended by the Board, and the proposed joint meeting of these four California Sections—Los Angeles, Sacramento, San Diego and San Francisco—to be held in San Diego in 1949 was noted.

Joint Cooperative Committee Authorized

A new committee, a joint cooperative committee with the Associated General Contractors, was authorized to promote better coordination of the activities of ASCE and AGC in areas of activities common to both organizations.

Formula for Local Section Allotments

The new formula for Local Section allotments as earlier recommended by the Committee on Local Sections was considered, as was a recommendation for a more liberal arrangement for reimbursing Local Section delegates to Local Section Conferences. These recommendations were referred to the Budget Committee for consideration and report at the October 1948 meeting.

Advertising for Professional Bids

Present practice of the Civil Aeronautics Administration, and occasionally other public bodies, in advertising for professional engineering services was discussed. It was the sense of the Board that the American Society of Civil Engineers strongly disapproves the practice of advertising for bids for professional engineering services. Steps were outlined toward ways and means to require public bodies to discontinue this disapproved practice.

Proposal for Redistricting

Tentative plans under the Committee on Districts and Zones looking toward eventual redistricting of the membership of the Society received marked attention. Each Director was requested to discuss the present tentative plan with his Local Sections and to transmit to the Committee on Districts and Zones a digest of Local Section reactions and recommendations.

Admission Procedure

Success of the newly adopted admissions procedure was reported. Under the new procedure but 25 percent of all applications received fall into category C, the procedure formerly used for all applications. A marked saving in time consumed in admission procedure was reported.

Committe on Technical Publications, Procedures and Costs

Progress of the Committee on Technical Publications, Procedures and Costs came in for extended discussion. The Committee reported consideration of several tentative schemes, all presenting many complications. A sampling of member opinion on some of the alternatives under consideration is planned by the Committee in the near future. The Committee expressed the hope that some new program for the publishing of technical papers can be evolved which will permit more prompt publication of more papers at lesser cost, or at no greater cost, than present publication procedures.

Dues Increase Amendments

At the July 21 business meeting of the Society (Summer Convention) some three hundred or more members present unanimously approved putting to letter ballot the current proposal for constitutional amendments to increase dues. At the same meeting President R. E. Dougherty gave his annual address. Both of these items are covered elsewhere in this issue.

PART OF WOMEN'S COMMITTEE in charge of arrangements for entertainment of visiting ladies at Seattle Summer Convention is pictured here. Seated, left to right: Mrs. F. H. Rhodes, Jr., Mrs. Dwight Gowdey, Mrs. E. B. Crane, Mrs. Bertram P. Thomas, who headed Women's Committee, Mrs. Allen S. Cary, Mrs. Walter Starkweather, Mrs. N. A. Carle, and Mrs. Carl Ganong. Standing: Mrs. T. H. Campbell, Jr., Mrs. W. F. Bow, Mrs. J. A. Troxell, Mrs. C. H. Brogunier, Mrs. R. W. Lincoln, Mrs. William H. Nelson, Mrs. E. F. Pugsley, Mrs. Cecil C. Arnold, Mrs. Cotton Howard, Mrs. G. F. Hopkins, and Mrs. E. L. Strandberg.

America's World Recovery Program Utilizes "Know-How" of Engineering Profession

How the engineering profession is being utilized in administration of America's world recovery program, with the 1947 President of ASCE already pressed into service, was told to the Engineers Club of Seattle in a luncheon address by Col. W. N. Carey, ASCE Executive Secretary. Colonel Carey's talk, one of several delivered before Seattle organizations during the Convention week as part of the Society's public relations program, was titled "The Engineer and World Recovery" and followed closely the speech he delivered before the Chamber of Commerce of Pittsburgh at the time of the Spring Meeting in that city (see Civil Engineering for May, page 50).

ASCE Past-President E. M. Hastings, chief engineer, Richmond, Fredericksburg & Potomac Railroad, Richmond, Va., has been called into service by Economic Cooperation Administrator Paul G. Hoffman, Colonel Carey pointed out in stressing the important role engineers can and should play in the recovery program by virtue of their close association with improved living standards, goal of the recovery plan.

"Mr. Hastings was selected as transportation representative of a special survey mission to China to study and report on industrial projects to be financed by ECA," Colonel Carey said. "The survey group will inquire into steps which can be taken to restore essential transportation facilities, to develop sources of fuel, power, export industries, and coal mining, and to improve port facilities. Following its study, the group will make recommendations as to priority of construction of projects which would contribute most to the improvement of economic conditions in China."

Development of Hydro Energy in Pacific Northwest Is Economic Asset to Entire Nation

Establishment by the federal government of a management approach to the programming, timing, and financing of an expanded development of hydroelectric power in the Northwest, "not as a gift from Uncle Sam, but as a basic tool to the free enterprise system" was advocated by Dr. Paul J. Raver, administrator, Bonneville Power Administration, Portland, Ore., at the opening-day luncheon of the Seattle Convention.

"Probably our very survival depends on the rapid and full development and use of the Columbia River development program as the tools of production for maintaining a high standard of living and for a growing population," Dr. Raver said. "This program is not a gift from Uncle Sam. It is fallacious to consider the development of this energy base only as a local matter for local prosperity. It is a great national asset. It represents the basic tools for creating new opportunities for new people to make a livelihood in new ways in a new part of our country. These tools are basic to the free enterprise system.

"In view of the non-reimbursable uses of the dams built partially for power, such as flood control and navigation, and the long-term risks involved in the reimbursable uses—power and reclamation—the development of a large-scale river system such as the Columbia takes more capital than can be privately banked. This banking job is one important reason for the government's appearance in the picture and presents at the same time one of the current problems facing the Northwest in securing an orderly development upon which private business can depend. That problem is one of financing.

"If the federal government is to do the job in the Northwest, it must recognize that the power aspects of the development are basic to the economy of the region and, indeed, to the nation. This means that power development on the Columbia River system must be differentiated from public works in both the planning and budgeting of the federal government. No longer can we build dams for power in this region on a public works basis only. The power supply must be programmed in accordance with the needs of a growing economy and an expanding population."

Pointing out that such power development as there has been to date in this region "has been almost a matter of accident, with dams authorized and begun primarily as public works projects to make jobs," Dr. Raver hailed the contributions made by the Grand Coulee and Bonneville power projects in World War II. Emphasizing that these wartime assets have, in peacetime, created huge industrial payrolls and taxable plants which to date have returned $125 million gross to the federal treasury on a gross capital investment of about $300 million, Dr. Raver said:

"Today the entire dependable power capacity of Bonneville and Grand Coulee dams has been committed, not only for this year, but for the next several years. The inability to provide power for these plants is costing the region employment opportunities for 25,000 men and a loss of taxable wealth amounting to about $25 million in plant investment alone.

"An excellent example of our failure to provide for expansion of production lies in the present state of the aluminum industry. Bonneville and Grand Coulee power now produces about half of the national output of primary aluminum. The metal being produced in our five reduction plants and one rolling mill is being used in more than 4,000 applications, and is applied in industries employing one million workers throughout the country."

Dr. Raver quoted from letters from I. W. Wilson, vice-president of the Aluminum Company of America, and R. S. Reynolds, president of the Reynolds Metals Co., urging increased power production in the Northwest.

The crisis of a power shortage as war plants resumed on a peacetime basis and business boomed, Dr. Raver declared, has brought complete reversal of the position "of those prophets of doom who doubted the dams would ever be used in the first place and who were against further expansion at the close of the war.

"If we should be unlucky enough to have a war in the next three or four years, it would be just too bad. It takes many months to build an aluminum plant. It takes five years to build a new dam."

In stressing the dependence of an expanding standard of living upon machine energy, Dr. Raver asserted that in the last century the combination of man plus animal plus machine has increased production fivefold, but that man's physical share in this production has shrunk from 15 percent to only 3 percent; the draft animal's share has dwindled from 79 percent to 1 percent, and the machine's share has increased from 6 percent to 96 percent. Dr. Raver drew the following conclusions from the figures he cited:

"No nation and no region within a nation can make progress and support an expanding population on an ever-rising plane of living standards except in terms of an assured energy base, an expandable energy base, and a cheap energy base. This is true because productivity is increasingly dependent upon the machine.

"Atomic energy, currently the despair of mankind, is yet the hope of mankind if the engineers can adapt its tremendous energy resources to the productivity of man. The other nations of the world today look with hope to America to give them the key to the support of their rapidly growing populations. The peace of the world hangs upon our willingness and ability to lend our brains and our machines to other peoples to raise their production per man hour and their standards of living."

Ballot on Dues Increase Authorized at ASCE Summer Convention in Seattle

CONSTITUTIONAL AMENDMENTS increasing and equalizing Society dues will be voted on this fall as a result of action taken at the business meeting at the ASCE Summer Convention in Seattle, Wash., July 21.

Petition No. 1 contemplates an increase in dues covering all members—$5.00 a year for Members, Associate Members and Affiliates, and $2.50 a year for Juniors. Petition No. 2 eliminates the residential dues differential in District 1. Both amendments will be sent to ballot as a result of the action by those in attendance at the convention business session.

Appreciation Due Local Committee

Words of appreciation are due the local meeting committee, under the general chairmanship of Fred H. Rhodes, Jr., for a highly successful convention, which brought together 650 engineers and their families from all over the country.

The program, combining technical sessions with excursions and entertainment, was formally opened on Wednesday morning, July 21, by Bertram P. Thomas, president of the host Section. The convention group was welcomed to the city by Mayor William F. Devin. President R. E. Dougherty, after a response to the mayor, delivered his Annual Address, which stressed the necessity of increasing Society dues if the present level of technical and professional service is to be maintained (see page 59). An over-all picture of the economic aspects of the development of Columbia River power, presented by Eugene L. Grant, professor of the economics of engineering at Stanford University, concluded the Wednesday morning business meeting (see page 63).

An address on the power resources of the Pacific Northwest, keynoting the theme of the meeting, was given at the general luncheon on Wednesday by Dr. Paul J. Raver, administrator of the Bonneville Power Administration. Dr. Raver's talk is excerpted on page 61.

Seven Divisions Meet

Descriptions of multiple-purpose water projects, under construction in and proposed for the Columbia Basin area, held the spotlight during the Technical Division meetings. A special general session was devoted to discussion of the cost allocation of such projects, under sponsorship of the Engineering Economics Division. There were also meetings of the Air Transport, Waterways and Soil Mechanics and Foundations Divisions. The Construction, Structural, and Power Divisions scheduled two sessions each. Accounts of these Division sessions are given on pages 17–22.

Eugene L. Grant

Paul J. Raver

As part of the Society's public relations program, ASCE officers were invited to address Seattle civic and professional organizations during the convention week. In addition, a larger audience was reached by the radio programs that disseminated information on ASCE activities and on the role of the civil engineer in society.

Excursions Enjoyed

Several excursions of interest from both an engineering and a scenic point of view were arranged for Friday and Saturday, July 23 and 24. On Friday, members were given their choice of a tour of the plant of the Boeing Aircraft Co. or an all-day trip to the Puget Sound Navy Yard at Bremerton, with luncheon at the Officers' Club. In the late afternoon both groups met for a boat trip on Lake Washington and Puget Sound, which afforded an interesting opportunity to inspect Seattle waterfront installations. A buffet supper was served aboard.

Mud Mountain Dam, an earthfill flood-control structure on the White River, was the objective of an all-day excursion by bus on Saturday. En route there was a stop for morning coffee at Enumclaw and a side trip into a heavy timber area, where the group had an opportunity to witness one of the state's leading industries. A spar tree was topped by the White River Lumber Co. Luncheon was served in Mt. Rainer National Park. The group was convoyed by the Washington State Patrol.

Social Events

To give local members an opportunity to meet ASCE officers and Headquarters staff, the Seattle Section sponsored a special pre-Convention dinner at Snoqualmie Falls Lodge on Tuesday, July 20. Those in attendance included members of the Board of Direction, who met on Monday and Tuesday, and delegates from 15 Western Local Sections who had an all-day Conference on Tuesday.

In addition to the traditional Wednesday evening dinner dance for members and their lady guests, there was a special dinner and entertainment for the men at the Rainier Golf and Country Club on Thursday evening. The ladies, in the meantime, attended a dramatic performance at the Showboat Theater of the University of Washington. Other entertainment for the women included a tea and special lecture at the Seattle Art Museum and a drive through the University of Washington arboretum and campus. Mrs. Bertram P. Thomas was in charge of the Women's Program.

The local ladies received many expressions of appreciation for their attentions to the Convention guests, which included keeping fresh flowers in all visitors' rooms.

Concrete Studies Sponsored by Engineering Foundation

RESEARCH IN REINFORCED concrete will be included in two new projects sponsored by the Engineering Foundation during the coming year. An appropriation of $5,000 has been made for conducting the project, which is to be directed by a research council representing the various interests concerned.

Similar amounts have been appropriated for each of two other civil engineering research projects, which are among twelve Engineering Foundation studies recommended for continuation. These two studies are on: (1) Strength and behavior of riveted and bolted joints, particularly in application to bridge structures, and (2) a study of structural members in different types of columns.

Engineering Foundation research projects are carried on at a number of universities and some engineering plants in cooperation with the four Founder Societies. Preference is given to fundamental projects that would not be undertaken by an industrial research organization.

Government Financing of Columbia River Projects Urged

ESTABLISHMENT OF A federal government corporation, having the right to issue revenue bonds to finance power and other projects on the Columbia River and other waterways, was proposed as a means of insuring a satisfactory rate of power development for booming postwar industry, in the business meeting address delivered Wednesday morning by Prof. Eugene L. Grant, executive head of Stanford University's department of civil engineering. Bonds issued by such a government corporation, which Professor Grant likened to the Port of New York Authority and the California Toll Bridge Authority, could be secured by the revenues from the sale of power from a single project or from an integrated group of projects such as those on the Columbia River, he pointed out.

"It is questionable whether a satisfactory rate of development which keeps ahead of demand can ever be maintained," Professor Grant said, "if appropriations for each of the elements of a completed project, from initial investigation of a damsite to the last turbine and generator and transmission line, must have separate consideration by the appropriations committees of Congress. With a government corporation plan of financing, it would be evident that power projects were self-liquidating and were, therefore, no burden on the United States taxpayers. The economic soundness of each project or integrated group of projects would be subject to the critical test of the investment market, and federal water power projects would be clearly differentiated from other federal water projects which are supported partly or entirely from tax funds."

Stressing the power shortage which has developed in the Northwest since war-born industries have continued to grow in that region, and the fact that the federal government has assumed the function of planning, building and operating hydroelectric power projects in the Columbia River basin, Professor Grant asserted:

"For this federal policy to continue to serve the public interest, the construction of needed projects should not be delayed by considerations related to the general level of appropriations for federal construction. This is particularly important because of the fact that several years generally elapse between the start of the engineering work on a hydropower project and the actual delivery of the electric energy."

Citing Northern California's experience of last spring when, because of unseasonably dry weather from early December to the middle of March, power rationing was put into effect, Professor Grant warned, in connection with his proposal for a change in federal policy:

"The real difficulty seems to be that not enough consideration is given to distinguishing those projects which can readily be put off from those which, in the public interest, ought to be constructed immediately and as rapidly as possible. Generally speaking, first priority on federal appropriations should be given to hydroelectric power projects in regions, such as the Pacific Northwest, where reserve power capacity is insufficient. The adverse consequences of a power shortage are much more serious than the adverse consequences, for example, of delaying completion of a river navigation project."

LINING OPERATIONS ON FRIANT-KERN CANAL, part of Central Valley Project under construction by Bureau of Reclamation, are viewed by members and guests of ASCE on inspection trip during Fresno Conference of California Sections (June issue of "Civil Engineering," page 57). Looking upstream from left embankment, photograph shows lining jumbo in left foreground and grooving and finishing jumbo adjoining it. Mastic and concrete curing compound machine is seen in distance.

Inter-American Professional Relations Are Discussed

CONTINUED IMPROVEMENT IN inter-American educational and professional relations in engineering in the past three years was reported by S. S. Steinberg, M. ASCE, dean of the University of Maryland College of Engineering, at the 56th annual meeting of the American Society for Engineering Education, held recently in Austin, Tex. The present closer relationship and better understanding among the engineers and engineering educators of this hemisphere was attributed by Dean Steinberg to close wartime cooperation between the United States and the other American Republics; increasing Latin-American recognition of the need for technical and industrial development to establish economic stability; and growing interest on the part of the profession in this country in the problems of engineers south of the border.

Among recent cooperative activities contributing to inter-American understanding, Dean Steinberg stressed the work of the EJC Commission on Latin America, which has been instrumental in making available to Latin-American engineering societies and universities the engineering quarterly, *Adelantos de Ingenieria*. Other organizations that have been active in distributing professional material in Latin America include the Division of Engineering and Industrial Research of the National Research Council, the Engineers Council for Professional Development, the American Society for Engineering Education and Stanford University.

Specialized engineering interests have also promoted better inter-American relations by sponsoring such gatherings as the recent Pan-American Mining Congress and the Inter-American Congress on Sanitary Engineering, according to Dean Steinberg. Probably the most important outcome of the joint efforts of the profession in this country and Latin America, he said, will be the first Pan-American Engineering Congress, which is scheduled to convene in Rio de Janeiro, Brazil, in 1949. "This congress will offer the first opportunity to lay the foundation for the solution of the many international engineering problems, both educational and professional, of interest and importance to the profession in all the countries of this hemisphere," he stated.

At the request of the State Department, Dean Steinberg has just submitted a proposal for completing the survey of engineering education in Latin America that he began in 1945. Because of time limitations, the survey covered only 12 of the 20 American Republics. Since then, Dr. Steinberg told the group, requests for inclusion in the survey have come from engineering and educational institutions in the other eight countries.

E. A Fisher, Hon. M. and Centenarian, Dies

HONORARY MEMBER Edwin A. Fisher, engineer emeritus of the city of Rochester, N.Y., and its first superintendent of city

E. A. Fisher, Hon. M. ASCE

planning, died at his home there on July 11—six days before his 101st birthday. In addition to being one of the Society's oldest members, Mr. Fisher was tenth on the list of veteran members in point of ASCE affiliation, having been a full member since 1888. He served as Director from 1905 to 1907, and was made an Honorary Member in 1929. For many years he was active in the Rochester Section of the Society.

Born in Royalston, Mass., Mr. Fisher was educated at the State Normal School at Westfield, after which he started his career as a teacher. Later, however, he turned to engineering, and in 1882 went to Rochester as chief assistant in the city engineer's office. From 1896 to 1914 he was city engineer, and from the latter year until his official retirement in 1927 he served as consulting city engineer.

Despite Mr. Fisher's retirement from the city payroll, he made daily trips to his office until recently and served in an advisory capacity. During his 65-year career in public service, he originated the city's water and sanitary systems, prepared a plan of parallel streets and boulevards for the city, and directed the location of the Barge Canal and its harbor site. Other important engineering work for the city included deepening the Genesee River as a flood-control measure. Mr. Fisher's work on installation of a modernized water system for Rochester included supervision of the construction of a second pipeline from Hemlock Lake, construction of the Cobbs Hill Reservoir, and development of the Canadice Lake source.

A past-president of the Rochester Engineering Society, in which he was active for many years, Mr. Fisher was the organization's only honorary member.

ASCE Is Well Represented at Soils and Large Dams Conferences

KEEN INTEREST IN technical aspects of the profession is evidenced by the large number of Society members attending recent international conferences in Europe. Signatures of 35 members in attendance at the Second International Conference on Soil Mechanics and Foundation Engineering in Rotterdam, Holland, were affixed to a letter received at Society Headquarters from Joseph D. Lewin, M. ASCE.

The names include Karl Terzaghi, Hon. M. ASCE, president of the conference, ASCE Vice-President Gail Hathaway, Walker R. Young, Gregory P. Tschebotarioff, D. P. Krynine, L. F. Harza, A. J. Ackerman, James B. Thompson, A. E. Cummings, and Harold F. Clemmer. The official Society delegates to this conference were: Frank A. Marston, chairman, Carlton S. Proctor, Joel D. Justin, T. A. Middlebrooks, Philip C. Rutledge, T. E. Stanton, and Charles B. Spencer.

Sponsored by the Netherlands government, the conference resumes the series initiated at Harvard University in 1936 and discontinued during the war. The conference was organized by J. P. Van Bruggen, director of public works, Rotterdam, T. K. Huizinga, director of the Laboratory of Soil Mechanics in Delft, and other Dutch engineers. Proceedings were in English.

Many of the U.S. representatives at the Soils Conference spent the preceding week in Stockholm, Sweden, attending the first International Congress on Large Dams, since the Washington, D.C., Congress in 1936. Society delegates to the congress were: Gail Hathaway, chairman, Joel D. Justin, L. F. Harza, C. P. Vetter, and E. M. Dycker, of Drammen, Norway.

A special tour of laboratories and construction projects in continental Europe and England was arranged early in July for those attending the conferences.

NEWS OF LOCAL SECTIONS

Scheduled ASCE Meetings

FALL MEETING

Boston, Mass., October 13–15
(Board of Direction meets October 11–12)

ANNUAL MEETING

New York, N.Y., January 19–21
(Board of Direction meets January 17–18)

Recent Activities

ALABAMA

PLANNING WAS DISCUSSED at the Section's annual summer meeting, in Montgomery, by R. S. Morris, district engineer for the Bureau of Community Facilities, Federal Works Agency, and Dr. Fred J. Lewis, dean of the Vanderbilt University School of Engineering. Mr. Morris described public works planning by states, counties, and cities with federal assistance, and Dean Lewis spoke on long-range planning for cities and communities. Dr. John M. Gallalee, president of the University of Alabama, gave the final talk of the afternoon session on "Education for the Present and for the Future." Arthur N. Beck, president of the Alabama-Mississippi section of the American Water Works Association, served as toastmaster at the dinner meeting, which was addressed by H. H. Houk, director of the technical staff of the State Building Commission. Mr. Houk, who has just returned from an assignment in Greece, spoke on "The Problems and Significance of American Aid for European Reconstruction." The committee in charge of arrangements for the meeting was headed by B. C. Goode, of Montgomery.

CENTRAL OHIO

A SYMPOSIUM ON job opportunities for young engineering graduates comprised the technical program at a recent dinner meeting. Participants were Prof. George Harding, of Ohio State University, who described recent developments in the field of aerial and instrument surveying and made predictions for the future; James D. K. Lyman, of the Mt. Vernon Bridge Co., who gave some general vocational advice; George B. Sowers, of the Ohio State Department of Public Works, who described opportunities in public service; and Al Harness, of the Jennings Lawrence Co., who spoke on the rapidly expanding field of municipal engineering and its increasing need for specialists. During the evening, the Section prize of Junior membership was presented to Lester Abram Herr, of Ohio State Univer-

sity. The Robert H. Simpson Prize went to Carl C. Walker, Jr., Roy Lee Stamm, and Robert Edwin McCort for their joint thesis on "Conservation of Beaver Creek in Greene County."

LOS ANGELES

THERE WAS A turn-out of 154 for the annual field day, held at the Rio Hondo Country Club in Downey, Calif. The afternoon program included golf, horseshoe pitching, and softball, with bridge for devotees of the soft life. Free beer and a softball game, in which the Juniors played the seniors, were added attractions. Homer Jorgensen was in charge of the Section team, and John C. Merrell, Jr., captained the Juniors. A dinner and special entertainment concluded the program.

ARIZONA

IMPORTANT FACTORS IN determining basic land values were outlined at a recent meeting by Karl Harris, agricultural engineer for the U.S. Soil Conservation Service. These factors include the type of soil and its texture, drainage, depth of subsoil, the amount of soluble salts in the soil, and the quantity, quality, and availability of water supply. Topography is also an important consideration, according to Mr. Harris, who stated that, in general, the value of land should be reduced by the amount of money required for proper leveling. A report on salaries and classifications, presented by O. K. Yeager, chairman of the Local Section EJC Committee, was discussed from the floor.

COLORADO

THE SECTION'S ANNUAL spring party, held at the Coronado Club in Denver, concluded the season's activities. There was an attendance of 89 for the banquet, which was followed by dancing and cards.

GEORGIA

OPERATION OF THE Atlanta incinerator, a rotary-kiln type affording continuous service, was described at a recent meeting by H. J. Gates. The only plant of its kind in the country, the incinerator was built at an approximate cost of $500,000 and put in operation in 1942. Gross revenues from the sale of steam and metal recovery have amounted to $446,554. Operating costs for the period have been $653,079, leaving a net cost of $206,524, or a net cost per ton of 35 cents. A special feature of the design is its arrangement for moisture control, permitting complete combustion, Mr. Gates stated. Progress made to date on the construction of Allatoona Dam was viewed by Section members on a recent joint inspection trip with the Society of American Military Engineers. The second state of construction was just beginning, following completion of the second-stage cofferdam.

SACRAMENTO

THE PRODUCTION OF vacuum concrete was demonstrated at a recent luncheon meeting by Walter L. Dickie, engineer for Pacific Vacuum Concrete, Inc., assisted by Milton S. Fromer. In the vacuum process, water is removed from the concrete, resulting in a dense hardened product that is desirable in hydraulic and other structures where resistance to water is important. Speakers at other recent weekly luncheons include I. F. Toomey, director of athletics at the College of Agriculture at Davis, who discussed the forthcoming Olympic Games, and Don Smith, manager of the Sacramento Airport, who described plans for expansion and improvement of the airport.

MIAMI

ENGINEERING FEATURES OF the proposed new water plant to augment the Miami supply were discussed at a recent dinner meeting by Frederick H. Weed, consulting engineer for the City of Miami. Mr. Weed stated that because of the rapid growth of greater Miami, the present expanded water supply facilities are already overtaxed and the new plant is a necessity. The proposed plant is being designed for a 40-mgd capacity, with provision for future addition of another 40 mgd. Obtaining wells free from salt-water intrusion was a controlling factor in selection of a site a few miles southwest of the city, the speaker said. Test wells of 18-in. diameter yielded 3,500 gpm with only a few feet of drawdown. The first units of the plant are scheduled for completion and operation in December 1949. Discussion of the feasibility of forming study and discussion groups on advanced engineering subjects concluded the program.

PHILADELPHIA

INSPECTION OF THE Swarthmore College campus and engineering buildings featured the afternoon session of the Philadelphia Section's closing meeting of the season, held at the college. The after-dinner speaker was Harry Wood, for many years head gardener at the college, who gave an illustrated talk describing the work of the Scott Horticultural Foundation.

Members of the Junior Forum heard J. Albert Roy, head of experimental struc-

MONTANA

FINANCIAL ASPECTS OF highway upkeep were outlined by R. H. Willcomb, of the Montana State Highway Department, at a joint meeting of the Section and the Montana State College Student Chapter in the closing days of the school year. Mr. Willcomb warned against becoming "highway poor"—that is, "building a larger plant than revenues can adequately cover." Al Williamson, retiring Student Chapter president, reported on the Northwestern Student Conference in Seattle and showed colored slides of construction work on Grand Coulee Dam and in the Columbia Basin, taken en route to the conference. The Section's annual award of Junior membership was presented to Harold S. Sitzman, who was cited "outstanding senior in the Student Chapter."

PICTURED AT RECENT JOINT MEETING OF Montana Section and Montana State College Chapter are, left to right: Fred E. Thieme, president of Montana Section; Walter Dunn, president-elect of Student Chapter; Daniel Dougherty, representative to Engineer's Council; George Herrin, new vice-president of Student Chapter; Al Williamson, retiring Student Chapter president; and Gordon K. Ebersole, secretary-treasurer of Section.

tures at the Philadelphia Naval Base, speak on "The Development and Test of Aeronautical Structures" at a recent meeting. Mr. Roy stated that early planes were able to fly, despite the fact that the designers of the day lacked technical knowledge and were, in many cases, following erroneous theories. Startling to the group was his statement that structurally the airplanes used in World War II are already completely obsolete.

PITTSBURGH

TRIBUTE WAS PAID to Lt. Col. Charles M. Wellons at a recent testimonial luncheon sponsored by the Section, the Pittsburgh Post of the Society of American Military Engineers, and the Pittsburgh Port Propeller Club of the United States. Colonel Wellons, who is retiring from the Army Corps of Engineers after many years of service, was honored in speeches by G. G. Greulich, president of the Pittsburgh Section of the Society; H. S. Stuckeman, president of the Pittsburgh Port Propeller Club; J. Carlson, president of the Pittsburgh Post of the Society of American Military Engineers; Col. F. H. Falkner, engineer for the Pittsburgh Engineer District of the Corps of Engineers; Col. W. E. Lowence, and Maj. Gen. W. E. R. Covell.

SAN FRANCISCO

PROBLEMS ENCOUNTERED IN planning a rapid transit, mass transportation system for the San Francisco Bay area were discussed by A. C. Jenkins, consulting engineer, at a recent meeting of the San Francisco Section. During the evening, Section awards were presented to outstanding civil engineering graduates from bay area colleges. These prizes, consisting of the initiation fee as Juniors in the Society, went to Marvin A. Larson, of Stanford University; Eugene S. Campi, of Santa Clara University; and A. C. Scordelis, of the University of California at Berkeley.

SEATTLE

A TALK ON the proposed Alaska Way Viaduct, designed to route arterial traffic through downtown Seattle, was given by Ray Murray, resident engineer for the Washington State Department of Highways, at a recent dinner meeting. Financing of the project, relocation of existing rail facilities, construction of a depressed roadway at the north end of the viaduct, foundation investigations, and test pile performance were covered in the talk.

SOUTHERN IDAHO

LOCAL WATER SUPPLY problems were discussed at a recent meeting by Mark R. Kulp, state reclamation engineer, and H. R. Vinson, manager of the Boise Water Corp. The former spoke on "The Legal Aspects of Water Rights for Domestic Supply in Idaho," and Mr. Vinson gave the history of the development of hot and cold water for domestic use in the city of Boise. ASCE Western Representative Walter E. Jessup was the principal speaker at a recent joint meeting with the Idaho Society of Engineers. Mr. Jessup explained the aims of the Society and outlined steps being taken to assure its functioning for the maximum welfare of the Local Sections and the membership.

TACOMA

ENGINEERS WITH THE U.S. Geological Survey presented a symposium on the Columbia River flood control program at a recent meeting. The first speaker was Fred M. Veatch, district engineer for the Surface Water Division of the Survey, who summarized hydrological aspects of the program and presented statistics comparing Columbia River floods of the past with the recent destructive flood. Then C. C. McDonald discussed methods used in determining flood frequency curves, supplementing his talk with graphs and slides of representative curves for the Columbia River.

TENNESSEE VALLEY

A TALK ON Chisholm Tavern and other historic spots in Knoxville comprised the technical program at a recent dinner meeting of the Knoxville Sub-Section. This was given by E. E. Patton, member of the Tennessee State Senate and former mayor of Knoxville, who emphasized the early history of Knoxville and the eastern part of the state. A resolution endorsing the Chisholm Tavern Project was unanimously adopted by the Section.

The development and use of catalysts was described at a dinner meeting of the Chattanooga Sub-Section by Murray Raney, president of the Gilman Paint and Varnish Co., in the absence of the scheduled speaker—J. B. Akers, chief engineer of the Southern Railway System. Officer requirements for a local Reserve Aviation Construction Battalion were outlined by Lt. Col. Dan A. Hodges.

Fall Meeting in Boston

IN HONOR OF the 100th anniversary of the Boston Society of Civil Engineers, the ASCE will hold its Fall Meeting in Boston, October 13–15, as part of the centennial celebration. Meeting headquarters will be the Statler Hotel. More detailed announcements of the meeting and the program will appear in early issues of "Civil Engineering."

STUDENT CHAPTER *Notes*

CARNEGIE INSTITUTE OF TECHNOLOGY

TWO HONORS WERE recently accorded Vernon Herbert Neubert of Cabot, Pa., member of the graduating class at Carnegie Institute of Technology, and of the Student Chapter there. He received the Tau Beta Pi fellowship for a year's graduate study in civil engineering, and will do work on vibration problems in the field of structural engineering at Carnegie Institute. Mr. Neubert also was selected from among 532 graduating engineers and scientists at the Institute to receive the "most promising senior" engineer award sponsored by Theta Tau, national engineering society.

IOWA STATE COLLEGE

A THREE-DAY inspection trip to engineering points of interest in Chicago was a recent highlight in Iowa State College activities. Faculty Adviser Loren Heiple conducted the trip. G. G. McCaustland, chief of the Kansas City Planning Commission, addressed a recent meeting on the history of Kansas City and outlined the city's future construction plans.

NEWARK COLLEGE OF ENGINEERING

"PAST AND CONTEMPORARY Bridge Design" was the subject of an illustrated lecture given by Julius B. May, design engineer for the American Bridge Co., before members of the Student Chapter at one of the closing meetings of the spring season. The speaker pointed out that while beautiful and lasting bridges were built during the Roman Empire, it was not until the nineteenth century that builders began to comprehend the laws of statics, the elastic properties of materials and the use of steel in bridge construction.

RENSSELAER POLYTECHNIC INSTITUTE

TWO MEMBERS OF one family—Robert Abel Dennison, Jr., and his father, both of Ilion, N.Y.—were graduated in civil engineering at the annual commencement exercises at Rensselaer Polytechnic Institute. Both were in the upper third of their class during the four-year accelerated course and both were active in Student Chapter affairs. Father and son served in World War II, the father in the Army Air Corps for a year and his son at Colgate University under the Navy's B-12 program. Both Mr. Dennison and his son will work for the New York State Department of Highways in the Utica office.

NEWS BRIEFS

ARBA Road Show Displays New Products of 330 Equipment Manufacturers

GREATER EFFICIENCY AND lower costs in heavy construction are presaged by the $25,000,000 array of new equipment exhibited by 330 manufacturers at the recent ARBA Road Show in Chicago.

Tremendous strides in the development of new construction equipment have been made since the last Road Show in 1940. This fact was clearly evident to the more than 125,000 highway construction men and engineers who came from all parts of the United States and 56 foreign countries to attend the Show and ARBA Convention.

In a relatively short span of years unprecedented developments in machinery have lifted road building and heavy construction in general from the depths of primitive methods and crude and inadequate tools to create an industry second only to that of agriculture.

Trends in earthmoving equipment in particular are toward greater capacities, faster speeds and greater maneuverability. Manufacturers, however, are not overlooking the intermediate sizes, with the result that complete lines of various types of equipment are fast becoming the rule rather than the exception. Greater portability is being stressed for many types of equipment from small pumps and generating units to such mammoth machines as crushing and screening plants. Here, as in the case of the heavy earthmoving machines, the development of the pneumatic tire has played an important part. The widespread trend toward greater portability was exemplified by the thousands of pieces of machinery which arrived at and left Soldier Field under their own power.

A definite increase in machines whose operations depend on the use of hydraulic and pneumatic devices is noted. Mechanical aids based on these principles make otherwise arduous tasks a matter of fingertip control—again increasing efficiency of operation.

Small tools essential to every large job have not been overlooked. Their continued development and introduction to the industry are eliminating many time-consuming, strenuous and costly manual operations.

As a demonstration of the applicability of modern construction equipment to the building of low-cost airports, a group of eleven well-known manufacturers presented to the city of Chicago a new plane-parking area 600 × 280 ft, constructed of soil cement. Visitors were able to witness the job for two periods each day except Sunday during the nine days of the Show. The project, at Chicago's Northerly Island Airport, was supervised by the Portland Cement Association and the work was handled by the Rock Road Construction Co., Chicago.

Held concurrently with the Road Show, the ARBA 45th Annual Convention presented a program for each of the nine days, scheduling ceremonies, board and committee meetings, technical sessions, receptions, band concerts and addresses. Speakers at the opening ceremonies were J. T. Callaway, president of ARBA, Dwight H. Green, Governor of Illinois, and A. F. Garlinghouse, Assoc. M. ASCE, president of the Associated Equipment Distributors.

On the second day of the meeting an International Reception was held in honor of all delegates from outside the United States. The Road Builders' International Banquet was held on the fifth day of the meeting in the Stevens Hotel Grand Ballroom with Mr. Callaway serving as toastmaster.

Among the speakers at the technical sessions were Maj. Gen. Philip B. Fleming, M. ASCE, Federal Works Administrator, Washington, D. C., who reviewed the tremendous progress that has been made in highway construction since 1920, and Charles M. Upham, M. ASCE, engineer-director of the ARBA, whose subject was "Status of 1948 Legislation Relating to Highway Aids."

Other Society members on the long list of speakers included H. C. Whitehurst, director of highways for the District of Columbia, Washington, D.C., who spoke on the Engineers' Day program; Harold S. Carter, professor of civil engineering at the University of Utah, who addressed the Educators' and Student Chapters' Day gathering on "The Value of Student Chapters to Technical Schools"; O. J. Porter, consulting engineer of Portland, Ore., who discussed "Compaction by Pneumatic Tired Rollers" before the Compaction of Soils Technical Session; W. W. Polk, first vice-president of the American Association of State Highway Officials, who spoke on All States Day; and Capt. Virginius L. Taylor, construction engineer of Mobile, Ala., and Tilton E. Shelburne, director of research for the Virginia Department of Highways, speakers on the Municipal and Airport Day program. Greetings were extended to the various sessions by Honorary Member T. H. MacDonald, commissioner of PRA.

ROAD AND AIRPORT building equipment is displayed on 1,250,000 sq ft of show space immediately to east and south of Soldier Field. Many exhibits of lighter equipment, publications, associations and organizations closely allied with road and airport construction are enclosed in stadium (left background.)

New Multi-Purpose Project for Columbia River Basin

PLANNED AS PART of a comprehensive, coordinated program of development of the Columbia River Basin for the purpose of flood control, navigation, power, recreation and possible irrigation, a project on the Snake River in Hells Canyon, Idaho and Oregon, has been approved in a preliminary form. Meanwhile, a separate report is being presented on this project at this time in order that it may be available for the consideration of the Congress in view of the continued and growing shortage of power in the Pacific Northwest. This report is particularly significant at this time, since this project, when operated in conjunction with other storage and flood control projects in the comprehensive plan, would have a significant effect in reducing floods such as the disastrous flood recently experienced.

The improvement, discussed a short time ago before a public meeting of the Columbia Basin Inter-Agency Committee at Baker, Ore., is to be called Hells Canyon Dam. The project will consist principally of a concrete dam approximately 710 ft high above foundation and its powerhouse with 850,000 kw of capacity in ten units. The reservoir will be approximately 89 miles long, extending upstream to within 13 miles of Weiser, Idaho. Foundations for four additional power units will be incorporated in the powerhouse.

Additional important features proposed include a low re-regulatory dam about ten miles downstream from Hells Canyon Dam, an extensive fish hatchery and pertinent works, facilities for public recreation and the necessary appurtenances and access roads. The reservoir would have its normal pool at El. 2,075 ft above mean sea level. The useful storage would be 3,280,000 acre ft, used primarily to store annual flood flows, to be released later to increase the low water flow of the Snake River. The improvement is estimated to cost the federal government about $358,400,000 based on December 1947 prices.

"Electrical Brain" Computes Graphs for ASCE Paper

IN PREPARING A series of graphs for a paper on "Aerodynamic Theory of Bridge Oscillations," in the ASCE PROCEEDINGS, D. B. Steinman, M. ASCE, found the "Electronic Analogue Computer" to be a tremendous time saver. Computation of 16 graphs, requiring 16 days by long hand despite the short cuts applied, was completed by the electronic device, more accurately, in 45 minutes.

The specific problem was to plot the integrated product of the ordinates of experimental pressure-distribution curves multiplied by sine and cosine functions of variable parameters. The empirical curves were reproduced on functional cams revolving against potentiometers in a servomechanism to yield a voltage output proportional to the variable ordinates. The variable multiplying functions were reproduced by feeding into the differential analyzer a simple second-order differential equation yielding the sine and cosine functions as its solution. The integrated product of the empirical and analytical functions was given directly by the machine.

The "electrical brain" is capable of solving linear as well as highly nonlinear differential equations. Units of the device, which was devised and built by the Reeves Instrument Corp. for use by the U.S. Navy, have been purchased by leading aircraft corporations.

World's Largest Airport Opens for Limited Operations

PART OF THE huge New York International Airport at Idlewild, Queens, which is being constructed by the Port of New York Authority as part of its postwar program of expansion of metropolitan airport and seaport facilities, was recently opened for operations on a limited basis. When completed, the 4,900-acre development will constitute the world's largest and most modern commercial airfield.

Three runways—measuring 6,000, 8,000 and 8,200 ft in length—are now in operation. Four more are planned, with an 8,000-ft instrument-approach runway, supplemented by a 3,000-ft approach pier extending into Jamaica Bay, scheduled for completion in December. The approach pier will be lined with 72 all-weather lights, visible for 1,000 ft in "zero-zero" weather, when there is no ceiling and no visibility. The ends of all the runways can be seen from the top of the 40-ft temporary control tower, which is equipped to operate on eleven radio frequencies.

A radar-equipped Peruvian International Airways DC-4 from Santiago, Chile, via Lima, Panama, Havana, and Washington, was the first regularly scheduled airliner to land at the International Airport.

Two large hangars are already completed and a number of other buildings are in various stages of construction. All the buildings going up now, modified Quonset hut types, are of a temporary nature, and officials expect that it will be from five to seven years before all the buildings of the central area—a space of 500 acres—are finished. Four principal structures—Customs, Inbound Cargo, Outbound Cargo, Operations and Emergency Buildings—cover 64,000 sq ft. The large Quonsets have been modified by means of steel uprights and girders. By using the round tops of three huts fairly large structures have been built.

Wind erosion has been practically eliminated by the successful planting of beach grass over 3,800 acres of the airport (see CIVIL ENGINEERING for January, page 34).

MODIFIED QUONSET STRUCTURE is used for combination customs, immigration, and public health building at International Airport. Adaptation of basic structures to airport's specific needs is made by Port Authority's engineering staff, in cooperation with Great Lakes Steel Corp., manufacturer. Interior is design of Port Authority's architect.

TEMPORARY 40-FT CONTROL TOWER, erected atop administration building, is equipped to operate on eleven radio frequencies, four for sending and seven for receiving. View shows front of terminal, looking toward immigration and customs building.

ASTM Convention Attracts 1,800 to Detroit Meeting

CEMENT, CONCRETE, AND concrete aggregates were among the many materials discussed at the recent 51st annual meeting of the American Society for Testing Materials in Detroit, Mich., which attracted an attendance of almost 1,800. An extensive exhibit of testing and research apparatus and laboratory equipment supplemented the five-day program of committee and general meetings. The organization's new officers were announced in the July issue of CIVIL ENGINEERING, page 69.

Of particular interest to the convention was a symposium on the deformation of metals as related to forming and service, and the effect of temperature on the properties of metals, in which E. L. Robinson, Assoc. M. ASCE, of the General Electric Co., presented a survey of data on high-temperature bolting materials. Another symposium, on outstanding developments in the field of mineral aggregates, received considerable attention because of the enormous demand for such aggregates as a material of construction. Factors of importance in atmospheric testing of low-alloy steels, a discussion of laboratory corrosion tests of iron and steel pipes, and a study of organic coatings used to prevent corrosion-fatigue failures were discussed in a session on corrosion. A symposium on reactive materials in concrete was of interest to those in the building materials field.

The proceedings of a symposium on load tests of bearing capacity of soils, presented at the 50th annual meeting of the organization, have been made available as special Technical Publication No. 79, which may be obtained from the ASTM, 1916 Race Street, Philadelphia, Pa. The price is $2.25 to members of ASTM, and $3 to nonmembers.

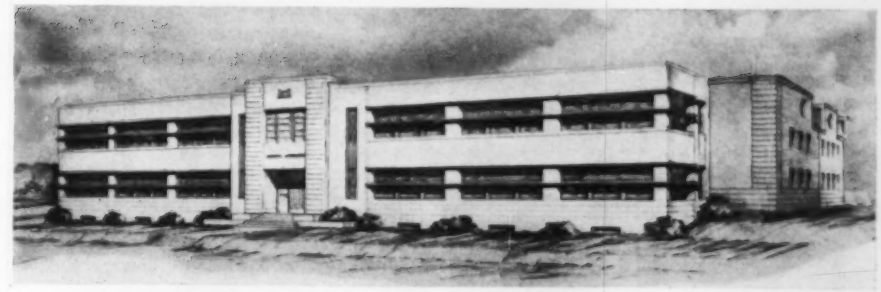
Missouri Basin Receives $90,000,000 Appropriation

APPROPRIATION of $90,000,000 for the Missouri Basin river development program—passed by Congress and signed recently by the President—will enable the Corps of Engineers to speed its work on 40 flood control and river channel projects in the twelve months ahead.

This third year of construction will see the entire Pick-Sloan plan for comprehensive basin development move well along the road toward accomplishment as authorized by Congress in the 1944 Flood Control bill, according to Maj. Gen. Louis A. Pick, Missouri River Division Engineer.

With the new appropriation, General Pick announced, new contracts will be let for work on several major dams under construction by the Corps. This action will permit substantial forward progress on the big Garrison Dam in North Dakota, Fort Randall Dam in South Dakota, the Cherry Creek Dam near Denver, and the Harlan County Dam on the Republican River in Nebraska. The Kanopolis Dam on the Smoky Hill River in Kansas was completed and dedicated in May (CIVIL ENGINEERING, July 1948).

Research Laboratory Planned for Waterways Experiment Station



THREE-STORY BUILDING OF CONCRETE AND MASONRY CONSTRUCTION, to be erected on 800-acre reservation of Waterways Experiment Station Sub-Office near Clinton, Miss., will supplement office and laboratory facilities of Concrete Research Division. Contract, calling for expenditure of approximately $256,000, has been awarded to Oden Construction Co., of Jackson, Miss. Completion within next year is planned.

Public and Private Construction Operations Show 40 Percent Increase Over 1947 Level

DOLLAR VALUE OF new construction put in place in May 1948 was the second highest monthly total on record since the end of the war, exceeded only by the October 1947 figure of $1,497 million, according to a recent Department of Commerce Industry Report. Other data for this period, reported by the Federal Works Agency in *Public Construction*, indicate that public construction work for the month continued to show a stronger seasonal upturn than private operations, increasing 18 percent over April as compared with a 9 percent advance for private work during the month. However, both public and private operations were about 40 percent above the May 1947 level

Expenditure of $338 million for public construction work in May brought the total for these operations for the first five months of 1948 to $1,232 million, 25 percent more than was spent in the same period a year ago. The January–May public-construction total accounted for only 20 percent of total new construction activity, a slightly smaller ratio than was recorded in 1947.

Private construction activity in May amounted to $1,111 million, bringing the cumulative private construction total for the first five months of 1948 to $4,851 million, 37 percent above comparable records for 1947. Most of this gain was due to expanded activity in the field of private residential construction. The cost of private housing work to date is estimated at $2,475 million, or 62 percent above the cost of similar operations during the first five months of 1947.

May construction contracts in the 37 states east of the Rockies established the highest peacetime dollar volume ever recorded for a single month, according to the F. W. Dodge Corp., fact-finding organization for the building industry. The total for the month of $970,789,000 was exceeded only once before—in June 1942, when war construction was at its peak. This near-billion total for the month was 44 percent greater than that reported for May 1947, and 11 percent higher than the total for April of this year.

Five Federal Agencies Join to Unify Bid Opening Dates

REPRESENTATIVES OF FIVE federal agencies conducting major construction programs have agreed to establish a system to coordinate bid opening dates on similar types of construction projects involving $1,000,000 or more and to avoid conflicts in such dates with large non-federal projects through the assistance of the Associated General Contractors of America.

Under the plan information will be obtained regarding large state, municipal, industrial and commercial projects scheduled for bids in order that federal projects may be advertised without conflict with similar non-federal work slated in the same areas. Participating agencies include the Bureau of Reclamation of the Department of the Interior; Bureau of Yards and Docks of the Navy Department; Corps of Engineers of the Department of the Army; the Federal Works Agency, including the Bureau of Community Facilities, Public Buildings Administration, and Public Roads Administration; and the Veterans Administration.

While coordination of bid opening dates among the major projects of the federal agencies concerned should result in increased efficiency in bidding procedure and wider competition, additional coordination with bid opening dates of large non-federal construction projects should likewise benefit the state, municipal or private awarding authority concerned. A master chart of bid opening dates on large construction projects of the agencies involved will be maintained in the office of the Chief of Engineers.

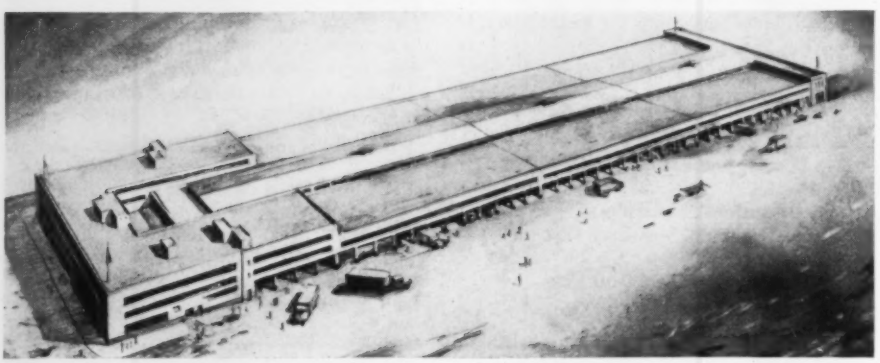
Large Motor Truck Terminals Planned for Metropolitan Area

As PART OF its long-range program for port rehabilitation of the Metropolitan area, the Port of New York Authority has begun construction of two huge union motor truck terminals. These projects, located in lower Manhattan and Newark, N. J., will be important factors in the reduction of traffic congestion in the metropolitan port area.

First in a projected series to be built by the Port Authority, New York City's $9,000,000 terminal will be capable of handling more than 2,000 tons of merchandise freight daily, and will save 1,830,000 truck miles a year. The Newark terminal, to be erected at a cost of $7,000,000, will enable the handling of over 2,500 tons of freight daily and the saving of more than 2,000,000 truck miles per year. Completion of both structures is planned for October 1949.

Consolidation and transfer of long-haul truck freight to small mosquito-fleet operators will expedite pick-up and delivery service in the terminal areas. Facilities for prompt turnaround at both terminals will increase the efficiency of road-haul units 20 percent, and both terminals will be serviced by their own maintenance and repair stations.

NEW YORK CITY'S UNION TRUCK TERMINAL (above), construction of which is now well underway, occupies three square blocks close to Holland Tunnel, steamship piers, and main arterial traffic routes. Roof of two-story 1,000×160-ft structure, with off-street bays for 144 trucks, will accommodate 70 complete tractor-trailer units for off-street parking. Freight platform, 800×80 ft, will be equipped with overhead chain conveyor serving both sides of island platform by means of platform trailers.



MODEL OF 1,158×200-FT MOTOR TRUCK TERMINAL, being built on 29-acre site in Newark, N.J., adjacent to northbound and southbound Routes 1 and 25, is pictured above. Design for two-story structure includes off-street parking bays for 160 trucks and 1,000×100-ft freight platform equipped with overhead chain conveyor for loading. Completed structure will constitute world's largest union truck terminal.

Western Construction Projects Listed by Bureau of Reclamation

UNDER THE HEAD of "Bid Calls Expected This Month," the Bureau of Reclamation lists in its *Advance Construction Bulletin* for July 1 work about to go forward on several large Western construction projects. While the bulletin states that all information published is subject to revision, the data given will provide an indication of the nature, location, and size of proposed reclamation projects.

CONCRETE DAM AND POWER PLANT
Missouri Basin Project, Montana

Location: On the Missouri River about 17 miles east of Helena, Mont.

Work: Construction of Canyon Ferry dam and power plant. The dam is to be a concrete gravity structure about 220 ft high and 1,000 ft long. The reinforced concrete power plant will house three 18,750-kva generators.

Concrete in dam	430,000 cu yd
Excavation for dam and power plant (common)	250,000 cu yd
Excavation for dam and power plant (rock)	90,000 cu yd
Excavation for roadway and switchyard (all classes)	210,000 cu yd
Concrete in structures	40,000 cu yd
Furnishing and placing reinforcing steel	4,700,000 lb
Placing penstocks and outlet pipes	675,000 lb
Placing radial gates and hoists	1,400,000 lb
Placing miscellaneous structural steel	600,000 lb
Installing frames and guides for gates	550,000 lb
Installing fixed wheel gates	500,000 lb

Time allowed for Completion: 1,400 days

MISCELLANEOUS CONSTRUCTION
Columbia Basin Project, Washington

Location: Coulee Dam, Wash.

Work: Completion of Grand Coulee pumping plant, warehouses A and B, installation of pump discharge pipes, crest railings and lighting; construction of feeder canal headworks to station 3 + 12.12, machine shop and central heating plant, addition to right training wall, and water storage reservoir for town of Coulee Dam; assembly of face caisson; and rock excavation for feeder canal between headworks and station 35 + 00.

Excavation (all classes)	340,000 cu yd
Furnishing ready-mixed concrete to other contractors and to government forces	50,000 cu yd
Furnishing and placing concrete in structures	136,000 cu yd
Furnishing reinforcing steel	6,600,000 lb
Placing reinforcing steel	14,300,000 lb
Sandblasting reinforcing steel furnished by government	2,000,000 lb
Furnishing steel and wrought-iron pipe	275,000 lb
Installing pump discharge pipes	11,250,000 lb
Erecting structural steel	2,200,000 lb
Furnishing and placing 1 to 3-in. thick asphaltic concrete	137,000 sq yd
Installing cranes	1,300,000 lb
Installing steel and wrought-iron pipe and fittings	485,000 lb
Furnishing and installing cast-iron pipe, fittings, and valves	320,000 lb
Installing electrical conduit	151,000 ft
Furnishing and installing electrical conduit	21,000 ft
Installing electrical conductors	45,000 lb
Furnishing and installing grounding materials	26,000 lb

Time Allowed for Completion: 1,080 days

"Out at the Airport" Series Describes Jet-Heat Effect on Pavements

ACCURATELY PLACED THERMOCOUPLES to measure the heat at various radial distances from tail pipe nozzles on jet-propelled aircraft disclose that the temperature of jet-heat has been found to be relatively low as the diameter of cones of heat increases only slightly. This information is contained in the current issue of *Out at the Airport*, publication of the Airport Division of the American Road Builders' Association.

The article, entitled "Effect of Jet-Heat on Airport Pavements," questions "the alleged destructive effects of aircraft jet-power plants' heat on airport pavements." Jet-heat applied to pavements, it states, was reputed to be in the order of 1,500 to 2,000 deg F. It was said to cause even strong concrete pavement slabs to crumble, and to destroy the plastic materials which form expansion joints.

While the heat immediately in the rear of the center of tail pipe nozzles is "very intense," the article points out, nevertheless, it declines quickly from 400 deg C at that point, cooling to 50 deg C at a point only 2 ft above or below the outlet of tail pipes. Horizontally, the heat likewise declines rapidly, being less than 80 deg C at a point 50 ft in the rear of the very center of tail pipe nozzles.

Aircraft engine designers scoff at stories of only partial combustion of fuels used in jet planes," according to the article. "But they realize that unavoidable fuel spillage occurs at points remote from runways and most taxiways. These areas are on aprons where aircraft engine-maintenance operations are carried on. The Army Corps of Engineers and Air Force specialists give these areas special consideration, and often install concrete where unusual spillage may be expected where engines are overhauled. This is done even where an airport's principal pavements might be asphalt. Stories arose that precious fuel remained unburnt in jet-propelled aircraft, and was then wastefully discharged onto airport surfaces from tail pipes of jet planes. Such spillage was said to act as a solvent, destroying the binding qualities of bituminous materials, and this was said to cause pavements to disintegrate, especially at take-off points on runways, reflecting far from complimentary implications concerning the ingenuity of the country's aircraft designers."

High velocity blasts of air discharged from jet engines, 800 fps at the tail pipe nozzle, do present a problem with respect to maintaining unpaved shoulders of runways and take-off areas, the article indicates. The force of jet blasts dislodges unbound particles which compose shoulders close to runways, and frequently destroys turf unless it has become deep-rooted. Paving engineers recognize the need for developing low cost cementing binders to prevent damage to close-by shoulders which results from unbelievable blasts of air generated by jet-propelled aircraft. Such engineers are not, however, too greatly impressed by unfounded reports about jet-heat and spillage of fuels destroying airport pavements.

New Federal-Aid Highway Act Signed by President

CONTINUANCE OF FEDERAL aid to the states for their long-range program of highway construction and improvement was assured by President Truman's signature of the Cunningham Bill, which was passed in the closing days of the 80th Congress after a Senate-House Conference agreement. The compromise measure, in continuing the Federal-Aid Highway Act of 1944 which was scheduled for expiration in June 1949, makes available to the states on a matching basis $450 million for the fiscal years ending June 30, 1950 and 1951.

Other road funds authorized by the act for each of the two fiscal years include $17,500,000 for forest highways; $20,000,000 for forest development roads and trails; $10,000,000 for roads and trails in national parks; $12,500,000 for access roads to federal lands; and $6,000,000 for roads and bridges on Indian reservations.

States Cooperate in Giving Professional License Exam

TO FACILITATE THE registration of an individual applicant, a plan of interstate cooperation has been established between two State Boards of Examiners of Professional Engineers separated by the width of the continent, those of Washington and New York.

A candidate for certification as engineer-in-training in Washington had recently moved to New York before the date of his required written examination. At the request of the Washington State Board of Registration for Professional Engineers, the New York State Board arranged to give the candidate the corresponding New York State examination instead and to grade the papers. The Washington Board has agreed to accept the results of this examination as a basis for granting the engineer-in-training certification of the State of Washington to the candidate, offering to reciprocate at any time.

New Madison Square Garden to Be World's Largest Hall

PLANNED AS THE world's largest convention and sports headquarters, capable of handling the largest meetings, expositions, and sporting events, the New Madison Square Garden in New York City, will be ready for occupancy in 1951. It will contain the largest indoor convention hall, the biggest sports arena ever built, will have garage parking facilities for 2,000 cars, and will be able to handle 50,000 people, at four expositions or conventions, at one time.

Site of the new garden will be an area of 241,500 sq ft, extending from 58th to 60th Street and from Columbus Avenue to Columbus Circle, bridged over 59th Street. The present Garden is on 49th and 50th Streets on Eighth Avenue, a distance of about ten blocks from the proposed new structure, which will be a six-story building.

The basement, ground floor and first floor of the new Garden will be used for parking, with the main entrance to the arena and the convention hall above the parking area. The main exposition hall will be 300 ×460 ft with 200,000 sq ft of exhibition space, including a 60-ft wide mezzanine, running along three sides.

Two smaller auditoriums are planned, each 100×150 ft in size, to accommodate smaller meetings and displays. The arena will be 300×460 ft, with a floor 220×110 ft and a capacity of 25,000 persons, as compared with the present Garden's maximum capacity of 18,500.

Housing Agency Sees Need for Higher Building Level

HIGHER LEVELS OF home building are necessary to keep pace with population growth and with the expansion of the rest of the economy, according to the Housing and Home Finance Agency in its current "News Notes on Housing," despite the encouraging rise in the volume of home building. This volume in 1947 totaled 845,600 privately financed non-farm dwellings, close to the 1925 all-time record of 937,000 family accommodations. The gross national product in 1947 totaled $229,000,000,000 as compared with about $94,000,000,000 in 1925. In the 22-year period from 1925 to 1947, population increased from 115,000,000 to more than 145,000,000, with the number of American families increasing 40 percent in that period.

British Survey Shows Heavy Costs for Technical Research

BASED ON INFORMATION provided by 420 firms engaged in various industries, a statistical survey of scientific and technical research being conducted by British industries in their own laboratories and works has recently been published. It is estimated, according to the survey, that British industry is now spending about 30 million pounds a year on industrial scientific research, which is being carried out by a staff of 45,000, of whom about 10,000 are qualified engineers and scientists.

More than half of the 420 firms participating are indicated by the survey to be in direct contact with universities and technical colleges. Sixty of the firms have endowed research scholarships or fellowships. Delay in the delivery of scientific and testing instruments and equipment is impeding research progress, the survey notes, at the same time emphasizing the value of industrial research as an instrument to help overcome the nation's economic difficulties.

Bibliography on Highway Planning Data Available

TO MAKE EFFECTIVE use of highway planning data obtained since the inception of the program of State-wide Planning Surveys, the library staffs of the Federal Works Agency and the Public Roads Administration have compiled an annotated and indexed bibliography for the Committee on Uses of Highway Planning Survey Data. This material, incorporating comments from the planning survey sections of the various state highway departments, has been made available as Bibliography No. 4 of the Highway Research Board. Inquiries should be addressed to the Board, 2101 Constitution Avenue, Washington 25, D.C.

Uses that have been made of the survey data, listed in the bibliography, include: Maps to show the state of the existing facility and the traffic service performed; origin and destination data to show desired directions of traffic flow; fiscal studies to determine the proper division of funds among administrative systems; motor-vehicle allocation studies to furnish information for a highway tax policy; road-life studies to obtain data for the analysis of annual highway costs; and the combination of the foregoing data to be used in determining the economic justification of project priority.

Supervising Engineer Tests Set by California Board

ANNOUNCEMENT OF A FORTHCOMING examination for the position of supervising engineer, maintenance and operations, is made by the California State Personnel Board. The state civil service position has a salary range of from $556 to $676 a month, depending upon qualifications. The final date for filing applications is August 28, with the examination scheduled for September 18 at Sacramento, San Francisco, Los Angeles and such other places in California and other states as the number of candidates warrants. Application blanks may be obtained from the State Personnel Board, Sacramento, San Francisco or Los Angeles.

Record Number Enroll for N.Y. State Examinations

A RECORD ENROLLMENT of 1,208 candidates for the New York State written Professional Engineer examinations in July has been announced by the New York State Board of Examiners of Professional Engineers and Land Surveyors. Of this number, 658 candidates took the preliminary examinations to qualify as Engineers-in-Training; 524 the final examinations for registration as Professional Engineers; and 26 the examinations for Land Surveyors.

For the first time, the number of candidates for Engineers-in-Training exceeded the number of Professional Engineer candidates, indicating that the desired pattern has now been established whereby future Professional Engineer candidates obtain their preliminary qualification as Engineers-in-Training soon after graduation.

R. Robinson Rowe, M. ASCE

"JOE, HOW OLD was Andy?" was the Professor's abrupt opening at the August meeting of the Engineers Club. "Remember, Joe, Andy had just registered his name, age, destination and names of others in his party for passage around the Horn 100 years ago, and when asked by the Purser for the ages of the other four, replied, 'They add to mine and twice their product is the year.'"

"I remember," said Joe Kerr. "Also you said the Purser was stumped, implying that a Civil Engineer should be smarter than a Purser. Well, I'm smart enuf to demonstrate why the Purser was stumped. The problem is to find x, where:

$$x = b+c+d+e$$

$$bcde = {}^1/_2(1948-100) = 924 = 2\times2\times3\times7\times11$$

Obviously one of the factors b, c, d or e is the product of two of the prime factors of 924. Thus, if $b = 2\times2$, then $x = 4+3+7+11 = 25$, and the seven alternative combinations for b give seven solutions, viz: $x = 25, 26, 30, 34, 36, 44$ or 84. Am I right?"

"No, Joe. Cal, what did he overlook?"

"That Andy had registered his age and that unity is an important factor in all enterprises."

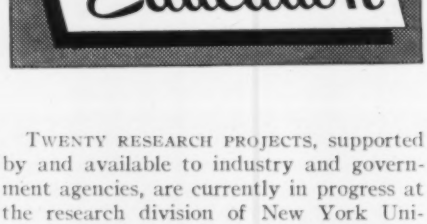
"Go on, Cal. Joe still looks puzzled."

"Well, Noah, if there were just these seven alternatives and the Purser knew Andy's age, he could figure the others. Since he couldn't, let's look at the *other* alternatives, considering that $bcde = 1\times1\times1\times2\times2\times3\times7\times11$. Using unity as a factor, we have 28 more combinations, running from $x = 1+7+11+12 = 31$ to $x = 1+1+1+924 = 927$. The ten lowest are: $x = 25, 26, 30, 31, 32, 34, 36, 36, 37, 40$. . .and the only repetition is that 36. That was Andy's age, and the Purser was stumped because he didn't know whether the ages of the other four were 2, 2, 11 and 21 or 1, 6, 7 and 22."

"Just so, Cal, and I might add that I spent a long evening finding such a number as 924 with many factors but only one duplication of the sum of four factors. The problem was suggested by another which I couldn't trace to its source, using the number 1,296 which has only one duplication of the sum of *three* factors.

"For our new problem, the background involves some of the history of Gooey Gulch Bridge, a timber structure of simple girders spanning 33 ft and carrying a uniform dead load of 1,000 lb per ft. Worried by its sagging profile, maintenance engineers propped it up 5 in. with a supplementary bent, making the girders continuous over two panels, but during the first rain the bent settled in the goo of Gooey Gulch. This increased the maximum moment in the left panel by 69 percent, that in the right panel by 96 percent, and the moment over the bent by 165 percent. How much did the bent settle?"

[Cal Kalters smarter than the Purser were Edward C. Holt, Jr., and a modest chap who hid behind the signature "Harry Earl." Also acknowledged are excellent solutions of the May survey problem from Raymond A. Warner, Edward C. Holt and Alfred F. Samuel. The trail toward the source of the "1,296" problem ran thru the faculty of the College of the City of New York; Professor Rathbun heard it from Professor Wills, who heard it from Professor Wolfe, who heard it from . . .]



TWENTY RESEARCH PROJECTS, supported by and available to industry and government agencies, are currently in progress at the research division of New York University's college of engineering, according to an announcement by Dean Thorndike Saville, M. ASCE. Jet and rocket propulsion, water purification and sewage disposal, studies of atmospheric energy and circulation, development of constant-level balloons, work on problems of soil trafficability, and aeronautical investigations of compressible flow, supersonics and smoke dispersion are included in subjects being studied.

SWIMMING POOL OPERATORS were given a special session for the first time at the recent 16th annual short course and conference on water supply and sewerage held at the University of Florida, Gainesville. Operators enrolled in water treatment sections for the first four days with the fifth day devoted to demonstrations and other work at the university swimming pool. A total of 143 persons representing 63 towns and 11 states attended the short course. Lectures on fundamentals and work in university laboratories, under supervision, made up equal portions of the 44-hour course which was divided into three sections—the advanced water treatment division, the sewage treatment section, and the elementary water treatment section.

ENGINEERING ADMINISTRATION and industrial management aid are being offered during the summer by the University of Mississippi in cooperation with Associated Management Consultants, Gulfport. The school of engineering and the school of commerce and business administration are participating in the program, with industrial engineering courses emphasizing production engineering as opposed to design.

Columbia Students to Make Community Surveys

SLIDERULE TECHNIQUE IS being applied to three Connecticut communities this summer by 200 Columbia University engineering students, according to an announcement by James K. Finch, M. ASCE, dean of the School of Engineering. In a novel project, originating at the university's summer engineering camp at Lakeside, Conn., the students are making detailed surveys of the utilities and industrial and civic problems of Thomaston, Litchfield, and Torrington, Conn.

Groups of students, ranging from 30 to 60 in number, will spend three weeks each conducting an intensive survey in one of the three communities. Investigations will include water supply and sanitation, housing, municipal services, power supplies, communications and other utilities. Certain industrial concerns in the communities are also being studied, with a view to determining their marketing problems, material and power needs, research and development requirements, and other factors that will be helpful to them.

Reports will be prepared by each group and made available to local government officials, Chambers of Commerce, and similar organizations. The project is being undertaken by invitation of the three communities slated for the survey.

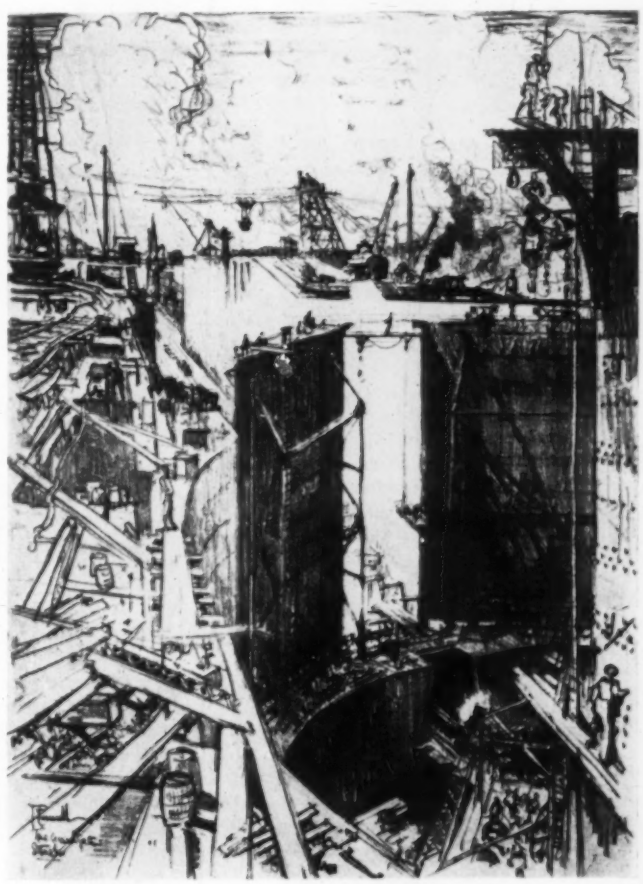
Foreign Students Are Guests on Engineering Plant Tour

MORE THAN 100 foreign students, representing 35 countries as well as Puerto Rico and the Canal Zone, attending Rensselaer Polytechnic Institute and Russell Sage College, both in Troy, N.Y., took part in a recent international students' day celebration in that city sponsored by W. & L. E. Gurley, manufacturers of engineering and scientific instruments. Representatives of 16 European, Asiatic, and South American diplomatic services were in the party on a tour of the Gurley plant, including a visit to an exhibition of historical and modern models of engineering and surveying instruments. (See CIVIL ENGINEERING, July 1947, p. 72.)

Waldo G. Bowman, Assoc. M. ASCE, editor of *Engineering News-Record*, was chief speaker at the luncheon following the inspection. Mr. Bowman deplored the restraints to freedom which require handwork when machines will do the job better. These restraints, he said, are at the root of most of the low living standards in the world today. He compared the United States installation of about 7 hp of mechanical power for each person in the country with that of two or less horsepower per person in most other countries. C. I. Day, Assoc. M. ASCE, president of the Gurley organization, also spoke.

Pennell Exhibit Features Engineering Subjects

EXTENSIVE COLLECTION of etchings and lithographs by Joseph Pennell on engineering subjects is currently on exhibition in Cooper Union engineering building, New York City. Additional Pennell works are on display to public in Cooper Union Museum, where recent artacquisitions are exhibited. Both display will remain in place indefinitely. Six lithographs, including one of locks shown here, are from Panama Canal series. Mr. Pennell went to Panama in 1912 while canal work was in progress. His drawings were made with lithographic pencil on lithographic transfer paper and brought to this country to be transferred to stone from which prints were made.



Wool Gatherings by WOOLLEY

PRESENT SCHEDULES OF the Washington State Toll Bridge Authority call for completion of the $14,000,000 Tacoma Narrows suspension bridge in 30 months.

GRAND COULEE PROJECT will irrigate 1,029,000 acres with water from Columbia River.

IN 1889 ONLY 5 percent of factory power came from electricity; in 1919 electricity acounted for 55 percent of industry's power; by 1939 the proportion was 90 percent; today it is almost 100 percent.

PRIVATELY OWNED AMERICAN passenger cars travel about 500,000,000,000 passenger-miles per year.

A LIGHT YEAR IS 5,865,696,000,000 miles or 186,000 mps for one year.

THERE ARE NEARLY 192,000 railroad bridges in the United States; the sum of their lengths is about 4,000 miles.

DURING WORLD WAR I, uranium was discarded as a useless by-product of radium.

MORE THAN 80 percent of New York's water supply is from surface sources.

OVER ONE-THIRD of the total reservoir capacity in the United States is allocated for power production.

THERE ARE MORE than 114,000 registered engineers in the United States.

COAL CONSUMPTION BY electric utility power plants was more than eight million tons in March 1948.

THERE ARE 1,000,000 more passenger cars on the road today than there were in 1941.

UTAH BITUMINOUS COALS yield from 30 to 45 gal of excellent oil per ton.

THE COLORADO RIVER takes 0.01 in. a year from its whole drainage area into Lake Mead behind Hoover Dam.

THE FIRST RESERVOIR of more than 5,000 acre-ft capacity for irrigation is believed to be French Lake in northern California, built in 1859.

DURING THE PERIOD 115–130 A.D. reservoirs were built to improve the water supply of Athens.

LESS THAN one-fifth of the civil engineers graduating this spring (1948) from 116 leading U. S. engineering schools are interested in entering highway engineering work.

DAN STILLSON, inventor of the Stillson wrench, would have been glad to sell his patent outright for $1,500, but he grudgingly accepted a royalty instead. Royalties brought him near $100,000.

ABOUT ONE-THIRD of the water that falls as rain or snow in the United States reaches the sea—about one-half in the eastern part of the country, only a small percentage on the Great Plains, and virtually none in the Great Basin.

THERE IS a $1,500,000,000 road program for 1948—the greatest in construction history.

Meetings and Conferences

American Association for the Advancement of Science. "One World of Science" will be the theme of the centenary meeting of the American Association for the Advancement of Science, to be held in Washington, D.C., September 13–17.

American Chemical Society. The 114th national meeting of the American Chemical Society will be held in three sessions. The Eastern Session will meet in Washington, D.C., August 30 to September 3; the Mid-West Session in St. Louis, September 1 to 10; and the Western Session in Portland, Ore., September 13 to 17.

Associated General Contractors of America. Headquarters for the mid-year meeting of the governing and advisory boards of the Associated General Contractors of America will be the Edgewater Beach Hotel, Chicago, Ill., September 13–15.

Chamber of Commerce. A Businessmen's Conference on Urban Problems, to be sponsored by the Chamber of Commerce of the United States, will be held in Detroit, Mich., September 13–14.

Illuminating Engineering Society. The National Technical Conference of the Illuminating Engineering Society will be held at the Hotel Statler, Boston, Mass., September 20–24.

THE MOLES, New York society of heavy construction men, will hold their annual clambake at Travers Island, New York Athletic Club, Pelham, N.Y., on August 18. Luncheon, beginning at 12:30 p.m., will be followed by golf and games. Shore dinner, entertainment, and swimming in the evening.

Instrument Society of America. The third Instrument Conference and Exhibit will take place at Convention Hall, Philadelphia, September 13–17.

Inter-American Conference on Conservation of Renewable Natural Resources. The first international meeting of its kind on conservation will be held at the Shirley Savoy Hotel, Denver, Colo., September 7–20. The conference has extended invitations to the 21 governments that are members of the Pan-American Union.

International City Managers' Association. Headquarters for the 34th annual conference of the International City Managers' Association will be the Grand Hotel at Mackinac Island, Mich., September 12–16.

National Council of State Boards of Engineering Examiners. The 27th annual meeting of the National Council of State Boards of Engineering Examiners will take place at the Hotel Utah, Salt Lake City, August 26–28.

New Publications

Traffic Engineering. Results of a joint survey of the urban congestion problem—made by the American Association of State Highway Officials, the American Public Works Association, and the Institute of Traffic Engineers—have been made available in a 137-page manual, entitled *Traffic Engineering Functions and Administration*. Issued as Publication No. 100 of the Public Administration Service, the bulletin may be obtained from the Service, 1313 East Sixtieth Street, Chicago 37, Ill., at a cost of $2.50.

Alluvial Deposit. Geological investigations of fine-grained alluvial deposits in the Mississippi Valley have been published by the Mississippi River Commission in two volumes under the title, *Fine-Grained Alluvial Deposits and Their Effects on Mississippi River Activity*. Inquiries regarding the set, which is priced at $2.50, should be addressed to the Mississippi River Commission, P.O. Box 80, Vicksburg, Miss.

University of Illinois Bulletins. A wide range of engineering experimentation is reported in recent bulletins of the University of Illinois Engineering Experiment Station, which may be obtained from the university, Urbana, Ill. The list includes Bulletin No. 33, "Flexural Fatigue Strength of Steel Beams," by Wilbur M. Wilson, M. ASCE, 20 cents; No. 10, "Rate of Propagation of Fatigue Cracks in 12-In. by $^3/_4$-In. Steel Plates with Severe Geometrical Stress Raisers," by Wilbur M. Wilson and James L. Burke, 35 cents; No. 26, "The Effect of Non-Uniform Distribution of Stress on the Yield Strength of Steel," by Dimitry Morkovin and Omar Sidebottom, 50 cents; No. 29, "History of Building Foundations in Chicago," by Ralph B. Peck, Assoc. M. ASCE, 40 cents; No. 23, "Experience in Illinois with Joints in Concrete Pavements," by Whitney C. Huntington, Frank E. Richart, and Carroll C. Wiley, Members ASCE, John S. Crandell, Vernon L. Glover, and J. Douglas Lindsay, $1; No. 22, "The Effect of Eccentric Loading, Protective Shells, Slenderness Ratios, and Other Variables in Reinforced Concrete Columns," by Frank E. Richart, Jasper O. Draffin, and Richard H. Heitman, Members ASCE, and Tilford A. Olson, $1; No. 11, "The Railroad Dynamometer Car of the University of Illinois and the Illinois Central Railroad," by John K. Tuthill, 20 cents; No. 8, "Studies of Highway Skew Slab-Bridges with Curbs," by Vernon P. Jensen, M. ASCE, and John W. Allen, Jun. ASCE, 75 cents; No. 51, "Second Progress Report of the Investigation of Methods of Roadbed Stabilization," by Ralph B. Peck, Assoc. M. ASCE, Rockwell Smith, and Thomas H. Thornburn, 25 cents; No. 46, "Progress Reports of Investigation of Railroad Rails and Joint Bars," by R. E. Cramer, N. J. Alleman, and R. S. Jensen, 25 cents; No. 30, "The Free Surface Around, and Interference Between, Gravity Wells," by Harold E. Babbitt and David H. Caldwell, Members ASCE, 50 cents; and No. 31, "Studies of Slab and Beam Highway Bridges," by Nathan M. Newmark, M. ASCE, and Chester P. Siess and Warren M. Peckham, Juniors ASCE, 50 cents.

Apprentice Training. To encourage apprentice training programs in the construction field, the Construction and Civic Development Department of the Chamber of Commerce of the United States has issued a pamphlet, entitled *Apprentice Training—Key to Productivity in Construction*. Inquiries should be addressed to the Chamber of Commerce of the United States, Washington, D.C.

Healthful Housing. Standards for healthful housing are outlined in a 90-page publication, *Planning the Neighborhood*, prepared by the American Public Health Association Committee on the Hygiene of Housing. The volume may be purchased from the Public Administration Service, 1313 East Sixtieth Street, Chicago 37, Ill., at a cost of $2.50.

Traffic Studies. A study on curb parking—undertaken to aid traffic engineers and public officials in proving that the control of all types of parking is to the best interest of the city as well as of individual land owners and users—is reported by the Eno Foundation for Highway Traffic Control in a booklet entitled *The Prohibition of Curb Parking*. Copies may be obtained free of charge from the Eno Foundation at Saugatuck, Conn.

Water Resources. Conservation and sound development of Ohio's underground water supplies is the subject of the Sixth Annual Report of the Ohio Water Resources Board for 1947. The Water Resources Branch of the U.S. Geological Survey is cooperating with the Ohio Water Resources Board on its program of investigation of underground water supplies. Inquiries should be addressed to the Water Resources Board, Columbus, Ohio.

Aerial Photography. The present status of aerial photography is indicated in a new index map, "Aerial Photography of the United States," published by the Map Information Office of the U.S. Geological Survey. Use of the status map makes it possible to determine whether photography is available for an area and the agency that holds the film. Inquiries should be addressed to the Map Information Office of the Geological Survey, Washington, D.C.

Perforated Cover Plates. Results of tests made to determine the mechanical properties of perforated cover plates intended as a substitute for lattice bars or batten plates in built-up box-type columns are detailed in a recent publication of the National Bureau of Standards, entitled *Perforated Cover Plates for Steel Columns; Compressive Properties of Plates Having Ovaloid, Elliptical, and "Square" Perforations*. Copies may be obtained from the Government Printing Office, Washington 25, D.C., at 10 cents each.

Hydrodynamics Research. Research problems in hydrodynamics currently under investigation at the Stevens Institute of Technology Experimental Towing Tank are reviewed in the 1947 Annual Report. Inquiries should be addressed to the Experimental Towing Tank, 711 Hudson Street, Hoboken, N.J.

Engineering Index. A digest of important information on technical, scientific, and economic problems, recorded last year in engineering magazines, special bulletins, and government reports from all over the world, has been made available by the Engineering Index, Inc. The volume, entitled *The Engineering Index 1947*, is priced at $50, with the privilege of purchase on a deferred payment plan. Inquiries should be addressed to the Index, 29 West 39th Street, New York 18, N.Y.

Highway Reseach. Tests made on Virginia highways to obtain data on surface characteristics for guidance in future design, construction, and maintenance policies are described in Report No. 5-B of the Highway Research Board, entitled *Skid Resistance Measurements of Virginia Highways*. These tests were reported on page 68 of the January 1948 issue of CIVIL ENGINEERING. Bulletin No. 10 of the Highway Research Board, *Land Acquisition and Control of Highway Access and Adjacent Areas*, summarizes ten memoranda of the Board on the subject. It also contains four special papers, dealing with the relation of express highways to city planning, problems of the state in highway right-of-way functions, relations of express highways to housing developments; and the problem of damages in loss of access rights.

City Planning. In *Master Plan for Kansas City*, the City Plan Commission of Kansas City, Mo., explains its long-range plan for development of the city and its environs to meet changing market and other conditions. Graphically illustrated with maps and plans, this manual may be purchased from the City Plan Commission at a cost of $1.

Fifteenth Annual Report of ECPD Now Available

THE FIFTEENTH ANNUAL Report of Engineers Council for Professional Development, for the year ending September 1947, is now available. This 50-page publication contains reports of the Committees on Student Selection and Guidance, Engineering Schools, Professional Training, Professional Recognition, Principles of Engineering Ethics, and Information, as well as of representatives of the constituent organizations. In addition, it lists Undergraduate Engineering Curricula in the United States for 1947, first by institutions and then by curricula including important options. Also included are the growing list of accredited programs of technical institute type, seven pages of committee personnel with addresses, the ECPD Charter and Rules of Procedure, and a price list of publications.

Copies are available from ECPD, 29 West 39th Street, New York 18, N.Y., at 50 cents each.

Cooper Union Issues Manual on Engineering Education

GROWING RECOGNITION ON the part of the Cooper Union engineering faculty of the "value and importance of a well-rounded engineering education, one that embraces a sizable proportion of humanistic-social courses," has prompted the compilation of an annotated bibliography, *The Humanistic-Social Stem of Engineering Education*, by the Cooper Union Library staff. Recently issued by Cooper Union as Bulletin No. 29 in its Engineering and Sciences Series, the bibliography may be obtained free of charge from the Librarian, the Cooper Union Library, Cooper Square, New York 3, N.Y.

Replacing an earlier publication of the Cooper Union Library, *The Non-Technical Aspects of Engineering Education*, the present publication surveys the available literature on the subject from the 1920's to the present and consolidates it for ready reference.

Metropolitan Boston Plans Improvement of Highway Facilities

AS A SOLUTION to Metropolitan Boston's complex traffic problems, the Joint Board for the Metropolitan Master Highway Plan has recommended a complete system of expressways to serve the entire area. The plan of the Joint Board, based on data derived from motor-vehicle origin and destination studies, has been made available in a 124-page illustrated volume, *Master Highway Plan for the Boston Metropolitan Area*. The data were obtained in a survey made by the Massachusetts Department of Public Works in cooperation with the PRA.

Included in the master plan are eight multi-lane, limited-access radial expressways, connected to a central belt route. Four of these expressways will comprise sections of the projected 40,000-mile, nation-wide network of interstate highways, proposed by the National Interregional Highway Committee and approved by the PRA and the various state highway departments. Under this program, the Boston area will be served by U.S. Route 1 to the south via Providence; U.S. 20 to the west through Springfield; U.S. 3 to the northwest through Lowell; and U. S. 1 to the north through Newburyport.

Improvement and, in some cases, relocation of these routes will be required to make them conform with interstate design standards. In all cases, basic standards of location and design, planned to accommodate anticipated traffic volumes over a 20-year period, will meet federal and state requirements for the interstate highway network.

Recommendations of the Joint Board also include functional plans for surface improvement of principal thoroughfares in downtown Boston, which will expedite the movement of traffic to and from the arterial routes. Supplementing these plans for new highways and for improvement of existing facilities, the program calls for extension and betterment of the rapid transit system; construction of the union truck terminals proposed by the Boston City Planning Board; plans for an improved and relocated market district; and plans for off-street parking facilities.

Engineering consultants to the Joint Board on preparation of the plan were Charles A. Maguire and Associates, in cooperation with DeLeuw, Cather & Co. of Chicago, and the J. E. Greiner Co., of Baltimore.

PROPOSED LONGFELLOW BRIDGE INTERCHANGE is one of many highway projects recommended in master plan—involving construction of expressways, improvement of existing thoroughfares, extension of rapid transit system, construction of union truck terminals, and improvement and relocation of market district—for solution of Metropolitan Boston's complex traffic problem.

NEWS OF Engineers

Donald P. Roberts is now in Guam where he will head work on water and sanitary design problems for his firm, the Frederic R. Harris Engineering Corp., of Knoxville, Tenn., one of a group forming "Pacific Island Engineers."

H. E. Howe, formerly with the Ambursen Engineering Corp., construction engineers of Houston, Tex., is now associated with the J. B. Dannelbaum Engineering Co. in the same city.

Harold E. Wessman, for the past 11 years chairman of the civil engineering department at New York University, has been named dean of the University of Washington College of Engineering. Holder of the bachelor's, master's, and doctor's degrees from the University of Illinois, Dr. Wessman has taught there, at Chiao-Tung University, Shanghai, and at the State University of Iowa. In addition to his teaching and administrative duties at N.Y.U., he has served as special engineering consultant to many organizations and is a past-president of the American Institute of Consulting Engineers. Dr. Wessman has also been active in the Metropolitan Section of the Society and on the ASCE Structural Division and the Committee on Engineering Education.

Harold E. Wessman

Edward S. Taub has opened an office for the practice of consulting engineering in New York, N.Y. He was formerly chief civil engineer in the Industrial Division of the Office of Economic Warfare, Washington, D.C.

Paul Morgan has resigned as city engineer of Algona, Iowa, to join a firm of consulting engineers at Belmond, Iowa.

Octavio Marcondes Ferraz has been elected technical director of the newly organized San Francisco Hydroelectric Co. in Rio de Janeiro, Brazil, which is to construct the Paulo Affonso Power Plant there. The plant, when finished, will have a capacity of 600,000 hp. Mr. Marcondes Ferraz was until recently head of the technical office of the O.M.F. Ltd., consulting engineers of Sao Paulo.

Clement J. Freund, dean of the college of engineering at the University of Detroit, is the newly elected president of the American Society for Engineering Education. **Thorndike Saville,** dean of the college of engineering at New York University, was named vice-president at the group's recent meeting at the University of Texas at Austin, and **F. M. Dawson,** dean of the college of engineering at the University of Iowa, was reelected vice-president and also president of the Engineering College Research Council of the ASEE for another two-year period.

Theodore O. Blaschke has left the employ of the New York City consulting firm of Strobel & Salzman to accept the position of associate engineer for Parsons, Brinckerhoff, Hall & Macdonald, of New York. Mr. Blaschke will specialize in hydroelectric and heavy construction design.

Frederick H. Warren, chief, production facilities control branch, Engineering Division, U.S. Atomic Energy Commission, has been appointed chief of the engineering-construction branch of the Engineering Division. Mr. Warren has been instrumental in organizing the Commission's export control program, which operates through close liaison with the Departments of State and Commerce and private industry. **Kirby K. Wyatt,** former chief of the engineering-construction branch of the Atomic Energy Commission, will remain on the staff of the Engineering Division as a consultant for construction management and special construction contract problems.

Charles E. Van Hagan, of Madison, Wis., recently was appointed secretary-treasurer of the Forest Products Research Society, succeeding **Thomas R. C. Wilson** who will resume consulting practice as a timber engineer. Mr. Van Hagan has been for the past four years a technical writer and reviewer for the U.S. Forest Products Laboratory and previously was with the Wisconsin State Highway Commission and with the Great Lakes Dredge & Dock Co., Chicago.

O. Z. Wrenn, Sr., O. Z. Wrenn, Jr., and **Charles T. Wilson** have organized the Wrenn-Wilson Construction Co. at Durham, N.C. They will conduct a general engineering and construction business.

William A. Sandberg and **Peter Serrell** recently organized the Sandberg-Serrell Corp., at Pasadena, Calif., where they will specialize in mechanical and structural design problems. Mr. Sandberg formerly was chief engineer of the Lacy Mfg. Co., at Los Angeles, and Mr. Serrell was on the design staff of the Southern California Cooperative Wind Tunnel.

William Voorduin of Chattanooga, Tenn., is in Argentina, where he will work on development of the upper reaches of the Rio Plata for the engineering firm of Parsons, Brinckerhoff, Hall, and Macdonald.

Herbert Ensz has resigned his position as head of the testing and inspection section of the Chicago Department of Subways and Superhighways to become structural project engineer for the Chicago firm of Sargent & Lundy.

Donald N. Becker recently resigned as engineer of bridge design with the Chicago Department of Public Works, after 24 years in the post and 36 years in the employ of the city. He is now chief structural engineer for A. J. Boynton & Co. of Chicago.

Anson Marston, Past-President and Honorary Member of the Society, and dean emeritus of the college of engineering at Iowa State College, was awarded the degree of doctor of engineering, honoris causa, at the college's 77th annual commencement. Mr. Marston started his teaching career in 1892 at Iowa State when he became professor and head of the civil engineering department. He became the first dean of engineering and director of the Engineering Experiment Station there in 1904, heading the division of engineering for 28 years. As chairman of the Iowa Highway Commission, he was largely responsible for the development of the present Iowa highway system. He retired from administrative duties in 1932 to teach and continue research.

Anson Marston

R. D. Goodrich, dean of the college of engineering at the University of Wyoming since 1932, has retired to become associated with Joseph T. Banner in a consulting engineering practice in Laramie, Wyo. Mr. Goodrich will be succeeded as dean by **H. T. Person,** formerly head of the department of civil and architectural engineering at the university.

Luther E. Olson, Cleveland, Ohio, engineer, was honored at the recent commencement exercises at Clarkson College of Technology when he received the honorary degree of doctor of engineering. Mr. Olson is a graduate of the college.

A. A. Kalinske, formerly chief hydraulics engineer for Infilco, Inc., of Chicago, has been appointed director of development for the company in charge of such work in the field of water, sewage, and waste treating processes and equipment.

Rear Adm. John J. Manning, chief of the Navy Bureau of Yards and Docks, Washington, D.C., recently was elected a trustee of Rensselaer Polytechnic Institute, his alma mater, and president of the Rensselaer Alumni Association. A member of the Civil Engineer Corps since 1918, Admiral Manning has held numerous important assignments, having been director of the Atlantic Division of the Bureau fron November 1942 to June 1945, and director of the Eastern Pacific Division from the latter date to January 1946.

Aaron P. Campbell recently was appointed vice-president in charge of the Houston, Tex., office of Gilbert Associates, Inc., engineers and consultants with headquarters in Reading, Pa.

Robert M. Angas, consulting engineer of Jacksonville, Fla., has been named chairman of the drainage and sewerage committee working under the City, County and School Improvement Committee of his home city. Last October Mr. Angas served as chairman of the Local Arrangements Committee for the Society's Fall Meeting in Jacksonville.

Walter O. Buehler has been elected a vice-president of the Gorman-Rupp Co. of

Engineering Facts about

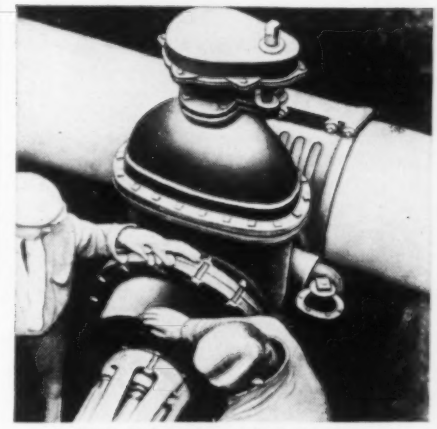
Johns-Manville TRANSITE PRESSURE PIPE

Making Large Service Connections

READY adaptability to standard waterworks practice is an advantage of Transite* Pressure Pipe which is of special importance when making large service connections. Thousands of such connections are in service today, installed in Transite supply and distribution lines with standard equipment and tools under a variety of installation and working conditions.

For tapping the line under pressure, conventional tapping sleeves, tapping valves and drilling machines are generally used. The sleeves are first leaded and caulked in the usual manner. Sleeves to fit all sizes of Transite Pressure Pipe are available from several manufacturers. Tough and strong, the pipe wall is, nevertheless, readily drilled; Transite's unusual machinability assures a clean cut.

In cases where the line can be temporarily removed from service, a commonly used method of providing large connections is to insert into the line a fitting† such as a tee having the required outlet size. To do this, a section of pipe is first removed from the line. The Simplex Coupling permits quick removal and with a minimum of trench excavation. Two stubs of pipe are then cut from this section and inserted into the bells of the fitting to form an assembly of equivalent length to that of the section removed. No problem arises in joining stub ends and fitting, since lead or compound joints are readily made with Transite. Replacement of the assembly in the line is easily and quickly made with the standard Simplex Couplings.

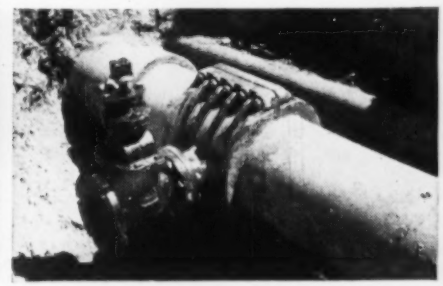


A 24-inch Transite main being tapped under full working pressure for a 20-inch branch connection.

A method sometimes used for making connections when the line is under pressure is the use of service clamps of the type equipped with double straps. These may be used for making service connections larger than those recommended for corporation stops inserted directly into the wall of the pipe or where multiple corporation stops are not used. After the service clamp and corporation stop are attached, the pipe wall is drilled with conventional drilling tools. Service clamps are not used for outlets exceeding one-quarter the diameter of the street main, nor larger than 4".

A previous advertisement in this series discussed tapping Transite Pressure Pipe for small service connections. A reprint is available on request. Address Johns-Manville, Box 290, New York 16, N. Y.

†The run of the fitting should have bell ends. Enlarged bells are used for class 150 pipe over 8" in diameter.



Conventional methods are used for making large service connections in Transite lines. Here are shown a tapping sleeve and valve being installed on a 12" line under pressure for a 4" outlet.

*Transite is a registered Johns-Manville Trade Mark

JOHNS-MANVILLE JM PRODUCTS

Mansfield, Ohio, manufacturers of centrifugal pumps. He will direct the design and development of new pumps for industrial and municipal use. Mr. Buehler resigned recently as vice-president of the Carver Pump Co.

William D. Shannon, Seattle consulting engineer and former Vice-President and Director of the Society, recently was appointed King County engineer at Seattle. Mr. Shannon was elected Washington State Representative from the 43rd Washington district in 1946 and is chairman of the Legislature's public utilities committee and a member of the state legislative council. Long interested in good government, Mr. Shannon has been active in Seattle and Washington politics for many years.

W. D. Shannon

Robert B. Richardson has been appointed director of highways and chairman of the Louisiana State Highway Commission. He has been with the highway department more than 25 years.

David W. Godat has announced the dissolution of the firm of Godat and Heft, consulting engineers of New Orleans. Mr. Godat will continue in general engineering practice under the firm name of David W. Godat & Associates.

John M. Henderson, professor of sanitary science in the Columbia University School of Public Health, recently returned from leave of absence to resume graduate teaching in public health engineering. While on leave, Mr. Henderson served in England and the Persian Gulf area as consultant in sanitation to the Kuwait Oil Co., Ltd., for two months and visited American oil developments in Saudi Arabia.

Oliver L. King, Abington, Pa., township engineer, recently was placed in charge of the sewer system.

John K. Minasian and **Carl B. Johnson** have opened an office for the practice of civil and structural engineering in Los Angeles, Calif.

Homer B. Pettit, colonel in the Army Corps of Engineers, recently retired from active duty after 30 years of commissioned service. He has opened a consulting office in Washington, D.C. At the time of his retirement, Colonel Pettit was chief of the legal division, Office of the Chief of Engineers, Washington. During World War II he served in the Persian Gulf Command as commander of the Desert District.

Edmund B. Besselievre recently returned from Argentina, where he served as sanitary engineering adviser to the North American Technical Commission and is now in charge of all sanitary engineering work for the Dorr Company's foreign division, with headquarters in New York. Mr. Besselievre has been with the Dorr Co. for 27 years, 13 of which have been spent as its South American representative. He was on leave of absence from his firm during the past year.

H. S. Sweet, research engineer for the Indiana Joint Highway Research Project, received a doctor's degree in civil engineering, from Purdue University at the recent annual commencement exercises. Except for honorary degrees, this was the first doctor's degree in civil engineering awarded by the university.

Deceased

Henry Baum Brewster (M. '09) died at his home at Thousand Island Park, N.Y., on April 19. His age was 73. For many years prior to his death, Mr. Brewster was president of Brewster & Williams, Inc., Syracuse, N.Y., engineering firm. Earlier in his career he had been division engineer of the middle division, New York Department of State Engineering and Surveying, in charge of barge canal contracts and of all engineering work on the Erie, Black River, Oswego, Cayuga, and Seneca canals.

Joseph Augustine Fahy (M. '41) chief of the construction division of the Veterans Administration, Washington, D.C., died there on June 1. Mr. Fahy previously was a professor of engineering, Catholic University of America, Washington, and had taught engineering at Columbia College, Portland, Ore. He was for several years engaged in construction work for the Oregon Shortline Railroad and the Tennessee Coal & Iron Co. During World War I he served with the Army Corps of Engineers.

Alfred Broughton Kissack (Assoc. M. '09) for the past 20 years in charge of the appraisal and special study department of Roy Wenzlick & Co., St. Louis firm of economists, appraisers, and counselors, of which he was a founder, died in a St. Louis hospital on June 7. He was 65. He began his career in 1904 with the government timber-testing plant at the St. Louis World's Fair. Later he was assistant engineer for the Missouri Valley Bridge & Iron Co., at Leavenworth, Kans., and contracting engineer with the Midland Bridge Co., Kansas City, Mo.

Wallace Corliss Lambert (Assoc. M. '00) died at his home in Gleasondale, Mass., on May 29, at the age of 79. Mr. Lambert was for some years principal assistant engineer in the Boston office of J. R. Worcester and had worked on steel design for the Boston Elevated Railway structure and the South Terminal Station, Boston. He had also been draftsman and assistant engineer in charge for the Boston Bridge Works, and assistant city engineer of Lowell, Mass.

Francois Emile Matthes (Assoc. M. '01) geologist and internationally recognized authority on glaciers, died at his home in Berkeley, Calif., on June 21, at the age of 74. Dr. Matthes was with the U.S. Geological Survey for 51 years, and at the time of his retirement in 1947 was senior geologist in the Washington office. He had conducted surveys in Glacier National Park, the Grand Canyon, Yosemite Valley, the Mississippi Valley, and many other parts of the West, and was the author of numerous articles and books published by the Geological Survey. Dr. Matthes was a twin brother of Honorary Member Gerard H. Matthes, retired director of the U.S. Waterways Experiment Station.

Arthur Montzheimer (M. '16) died recently at his home in Aurora, Ill., at the age of 79. He retired some years ago as chief engineer of the Elgin, Joliet & Eastern Railway, a position he had held since 1903. As chief engineer, Mr. Montzheimer supervised construction of terminal buildings at East Joliet, Ill., and Gary, Ind., and of the railroad yards at South Chicago, Gary, Joliet, and Waukegan, Ill. Prior to 1903, he was for 16 years with the Chicago & Northwestern Railway as superintendent of bridges and buildings and in other engineering capacities.

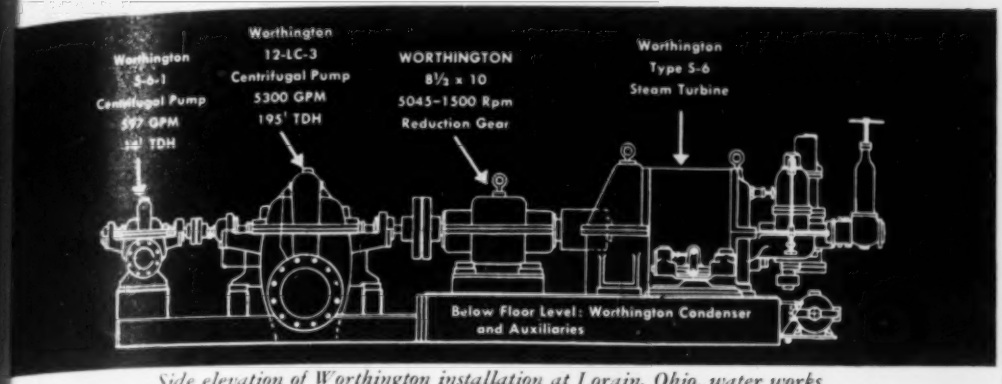
Roger Wolcott Olmsted (Assoc. M. '18) chief engineer of the Foster & Kleiser Co., San Francisco, died at his home in San Mateo, Calif., on May 19, at the age of 58. Mr. Olmsted began his career in 1913 with the South San Joaquin (Calif.) Irrigation District, which he had served as levelman, assistant engineer in charge of canal location and drainage work and design and construction of concrete structures, and as chief engineer.

William Quiggle Reeves (Jun. '40) was killed in a cave-in on the Tucumcari Irrigation Project, Tucumcari, N.Mex., in April. Mr. Reeves recently had been promoted from acting construction engineer of the project to construction engineer. His age was 31. Since his graduation from the University of Colorado in 1940, Mr. Reeves had been with the Bureau of Reclamation. He had been junior and assistant engineer at Kremmling, Colo., and Altus, Okla.

Gadsden Edwards Shand (M. '06) consulting and valuation engineer for the electrical division of the South Carolina Public Service Commission, died recently at his home in Columbia, S.C. Mr. Shand, who was 80, had had an engineering and architectural practice in Columbia for many years, specializing in the construction of mill buildings and industrial plants. He had also made a survey of development plans for the Aiken Augusta Railway Co.

George Albert Soper (M. '05) retired consulting engineer of Hampton Bays, N.Y., died in a hospital at Southampton, N.Y., on June 17. He was 78. Widely known as a sanitary engineer, Dr. Soper had done important work in the field of typhoid, being the first to discover human carriers of the bacillus. He began his career with the Boston Water-Works, and did notable work as sanitary engineer in charge of reconstruction following the Galveston hurricane of 1900. Later he served as sanitary engineer of the New York City Department of Health, and as president and director of the Metropolitan Sewerage Commission of New York. He drew up a sewage disposal plan for the city and a ventilation system for the New York subways, which was finally adopted by the Transit Commission.

(*Continued on page 82*)



Side elevation of Worthington installation at Lorain, Ohio, water works

A Lot of Water Has Gone Through This Pump

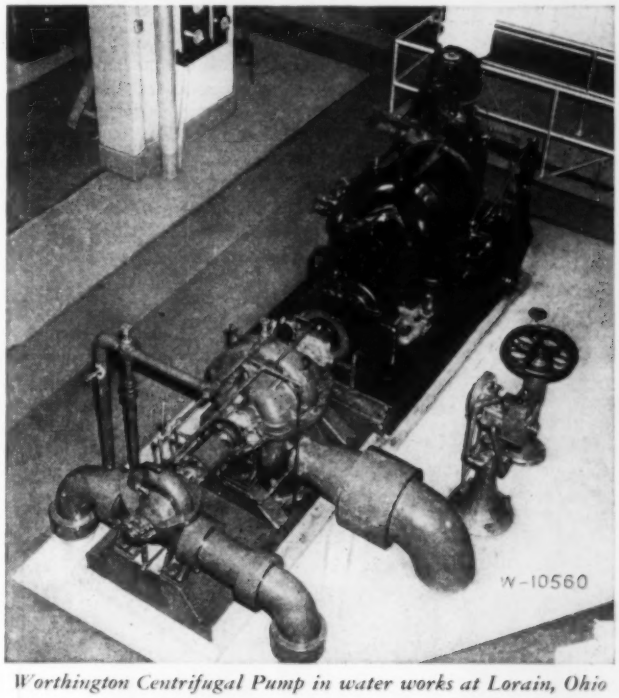
More than ten years ago, the city of Lorain, Ohio (a community of 45,000 people) installed a Worthington centrifugal pumping unit to deliver seven and one half million gallons of water per day.

H. B. Wallace, chief engineer of the water works, reported recently that this Worthington pump has operated continuously ever since with never a shutdown except for routine maintenance.

During the majority of the time the pump has handled the entire capacity load; and at various times it has been required to handle appreciable overloads.

The complete water works unit consists of a 7.5 mgd 12 in. pump that is driven by a geared steam turbine with the main pump shaft double extended for connection to the condenser circulating pump; also a surface condenser with its auxiliaries.

All elements are of Worthington manufacture, thus giving undivided responsibility for proper operation.



Worthington Centrifugal Pump in water works at Lorain, Ohio

Springfield, Minn. Purchases Third Worthington Turbine Generator Unit

The city of Springfield, Minnesota, has for a long time operated its own electric power plant.

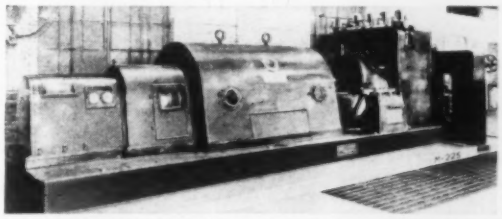
In 1895, electric power was furnished in a limited way from 5 to 10:30 P.M. each day by a 40 kw generator driven by gasoline engine. In 1902 a steam engine with 50 kw belted generator was installed. In 1915 this was replaced by a 100 kw steam engine, and the system was converted from direct current to alternating. At the same time a heating system for the business district was installed, using the exhaust steam which would otherwise be lost to atmosphere.

Further expansion came in 1923 with a 250 kw steam engine. By 1937 the electric load had so far outstripped the heating load that it became necessary to exercise economy in order to reduce cost of operation. A 750 kw Moore automatic bleeder condensing turbine was installed; it was designed for 400 lb steam pressure, 670 F temperature.

Then the necessity for adapting all the modern practices of steam plants—including higher pressure and temperature—led to the purchase of a 1000 kw Moore automatic bleeder condensing turbine.

Acquisition of REA power contracts necessitated further expansion of the facilities. Last year a 2000 kw Worthington automatic extraction unit was put into operation along with a new high pressure boiler.

The plant now realizes maximum efficiency from the advantages of modern design.



Worthington 2000 kw turbine generator, City of Springfield, Minnesota

NEWS

FROM THE PUBLIC WORKS FRONT

AS REPORTED BY THE DEVELOPMENT ENGINEERS, FIELD SERVICE REPRESENTATIVES AND CUSTOMERS OF WORTHINGTON

Blue Brute Truck Mixers Take Peak Loads in Stride

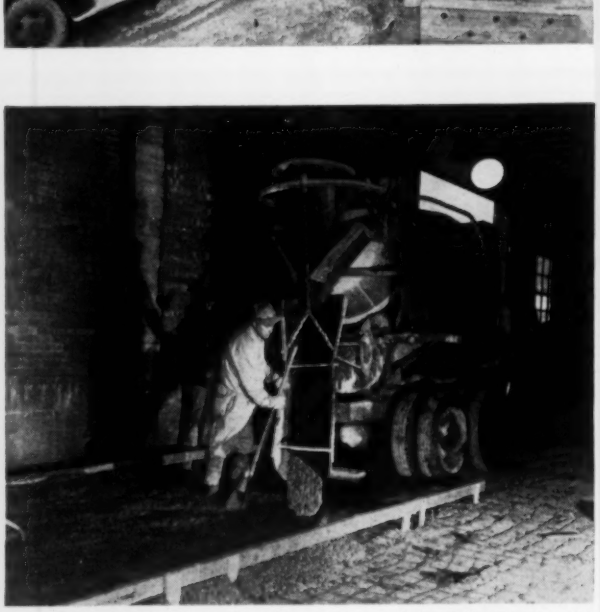
They're building in the Northwest these days, and one of the most enterprising among the builders is the Hitz Construction Company of Billings, Montana.

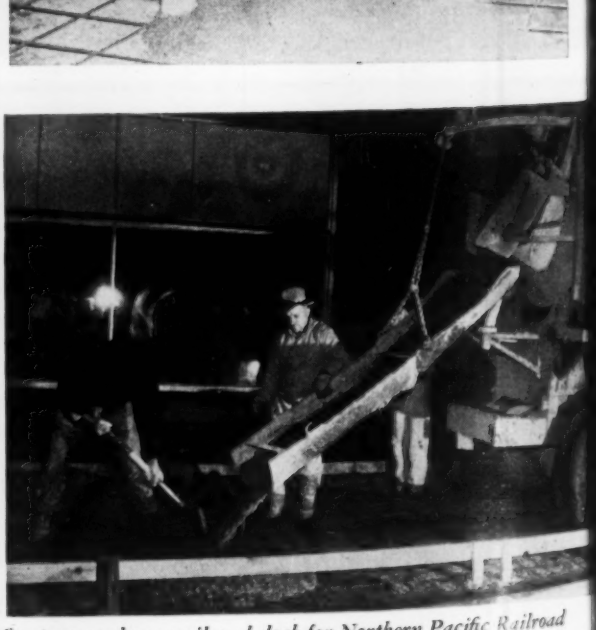
This company, in order to speed service and maintain quality, operates a fleet of nine Blue Brute Truck Mixers to furnish ready-mix concrete continually even under peak-load conditions.

The first Blue Brute mixer put to work by this company was a Worthington-Ransome Blue Brute 56-S Big Building Mixer, followed by two Blue Brute Hi-Up truck mixers. These mixers gave such fine service that the Hitz company steadily increased its Blue Brute equipment to a fleet of nine within one year.

At the present time, the Hitz Construction Company's Blue Brutes are completing a large unloading dock for the Northern Pacific Railroad—a contract which involves several thousands of cubic yards of concrete. The Blue Brute fleet has begun pouring concrete for the Carter Oil Company in connection with its $30,000,000 refinery program scheduled to be under full construction early in 1948. Equipped with an efficient plant, Hitz is prepared to furnish quality concrete to all the hundreds of large and small industries now under construction or being planned for Billings, Montana.

Mr. Hitz writes: "The Hitz Construction Company is building its business on service and quality of materials. The Blue Brute Hi-Up truck mixers, mounted on tandem-axle trucks, are a large factor in giving this service as they can get into spots and deliver concrete to those hard-to-get-at forms where no other mixers could do the job." Incidentally, Blue Brute "blue" was selected as equipment colors—a feature which has caused one contractor to remark that "they are the finest looking truck mixers in town."





Photos show Blue Brutes at work for Hitz Construction Company on large railroad dock for Northern Pacific Railroad

Worthington Pump and Machinery Corporation
Harrison, N. J.

NEWS

Sewage Gas Engine Returns $199,000

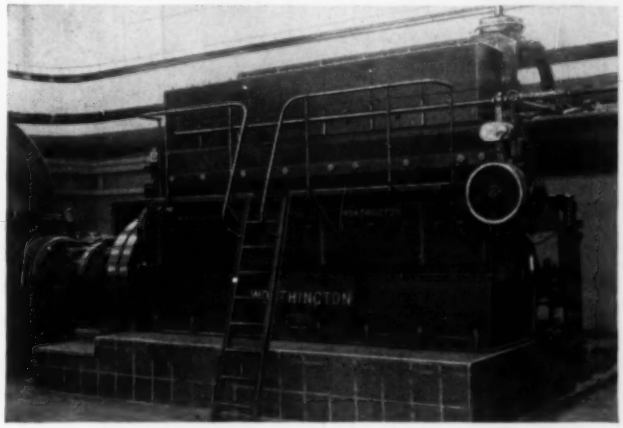
The annual report of the Fort Wayne (Indiana) sewage treatment plant reveals a 1946 saving of $38,000 by the 465 hp Worthington gas engine installation. This brings the total six-year saving to $199,000.

This plant, considered one of the outstanding municipal developments in the country and a focal point for inspection tours by engineers from other communities, was completed in 1940. Fort Wayne had been mandated by the Indiana State Board of Health to cease pollution of the Maumee River, and now the treated sewage is so free of offensive material that the river is capable of sustaining fish life.

Total sewage treated in 1946 amounted to 6,648,960,000 gallons—an average of 18.73 million a day. From this 7,000 tons of sludge was removed, and into it 5,345,890,000 cubic feet of air was pumped.

The Worthington gas engine was originally purchased at a cost of $30,000. The estimated saving is based on what it would have cost otherwise for additional electric power.

The engine contributes to heating the sludge digesters. The sludge is pumped in liquid form into four covered digesters where it is decomposed by bacteriological action, producing methane gas. Heat from the circulating water in the engine is used to raise the temperature of the sludge to the desired point for proper bacteriological digestion. In 1946, nine billion BTU's of heat went from the engine to the digesters—equivalent to 650 tons of coal.



Worthington Sewage Gas Engine—Fort Wayne, Indiana, Sewage Treatment Plant

New Diggers Join Blue Brute Line

Two new hard-hitting, light-weight air tools are announced as additions to the Worthington Blue Brute line of construction equipment. They are the Blue Brute W-14 Clay Digger and the W-114 Trench Digger.

New Blue Brute W-14 Clay Digger

Both machines were developed in the field by owners and operators, and were proved in action by them on their own jobs before being released to the trade. They are consequently designed specifically for easy operation and convenience, and their many refinements of design permit considerably more hours of actual working time.

A typical example of the engineering technique incorporated into the W-14 and W-114 is a built-in lubricator to add long life and prevent unnecessary work interruptions. Both machines have an air inlet swivel, which allows the operator to swing the hose in any direction without tangling or kinking. Replaceable bronze cylinder bushing reduces maintenance costs and increases life of cylinder. The exhaust is directed away from the operator, improving his comfort and efficiency.

These new tools contain an entirely different, patented, double-metering tubular valve of Worthington design and construction. This revolutionary valve gives positive action, unaffected by valve wear, and assures low air consumption through accurate air measurement.

New Blue Brute W-114 Trench Digger

The W-14 Clay Digger is 19⅝ in. long, and weighs only 21 lb, without spade. The W-114 Trench Digger is 29⅝ in. long and weighs 29½ lb, without spade.

John Clarence Ulrich (M. '08) retired consulting engineer of Denver, Colo., died there on June 5, at the age of 89. Mr. Ulrich began his career in Colorado with the Union Pacific and Chicago, Burlington & Quincy railroads in the 1880's. Later he did extensive work in canal construction in Colorado, Wyoming, Utah, and Washington. He entered private practice in Denver in 1897 as a consultant, specializing in hydraulics. He retired in 1928.

Unit-Price Bid Forms Protect Owner, Contractor, Engineer

(*Continued from page 37*)

hand and machine work and also for lagging.

Where bid quantities are given for unit items of work, such quantities should be as nearly accurate as possible, and the responsibility for their accuracy lies with the engineer. In case of an appreciable error, provision should be made to adjust the contract unit prices to conform with the change in quantity. An example of this would be a case where a unit price was given for an item of structural concrete in place, for instance, as in a bridge job. Generally this unit price for structural concrete includes forms, falsework, finish, plant set-up, concrete, overhead and profit. If there is an appreciable variation in the actual quantity of concrete, it can readily be seen that the result would be unfair to the owner in case of an increase in quantities, and quite unfair to the contractor if the quantities are decreased, as certain fixed charges are included in the unit cost.

Field Test Procedure for Unwatering of Davis Dam

(*Continued from page 27*)

though there may be a rise in the water table within the central part of the cofferdam area due to the heavy flow found in the deep gravel strata in the deep-well pumping tests.

In the downsteam end of the cofferdam area, and adjacent to the spillway and powerhouse on the Arizona bank of the river, the tailrace for the powerhouse is to be carried down to an average elevation of 480 over a triangular area roughly 400x500 ft. The unwatering of this area will be handled by two lines of well points, one 700 ft and the other 1,000 ft in length, fed by 170 and 230 points respectively, with three pumps for each header. With a header elevation of 492, these two lines will be effective for the tailrace area, and for some springs which are known to exist at the upstream end of the powerhouse foundation.

There still remains the deep cutoff under the main section of the dam, which will be 120 ft wide at the base, 330 ft wide at the top, about 900 ft in length from one rock abutment to the other, and 55 ft deep below the stripped-off base of the dam. The well points near the upstream cofferdam will probably be effective down to El. 490, and those in the tailrace and near the downstream cofferdam can probably maintain at least this same water level or lower. Because of a possible resurgence of water level within the cofferdam, the uppermost headers at the cutoff will be set at El. 500, and the two stages set below that elevation will bring the effective level of the lowest stage to El. 452, or 3 ft below the base of the cofferdam.

If the results from the well points near the cofferdams show the procedure to be feasible, all stages of the cutoff well points will be lowered as much as 5 ft, so that the maximum effective depth of the lowest well points will be at El. 447, or 8 ft below the lowest cutoff excavation level. In the three stages on each slope of the cutoff trench, some 450 well points will be distributed, probably not at equal intervals, as the test borings for the dam indicate a wide divergence in subsurface sand gradation and even the presence of some fine gravels above the base of the cutoff trench.

Use 30 Pumps with Several in Reserve

In all, some 30 self-priming centrifugal pumps will be in active use during most of the dewatering period, with seven to ten additional pumps in reserve for installation as needed. The 30 active pumps will be fed by about 2,000 well points, but about 2,600 to 2,700 points will be installed to insure the complete shutoff of all incoming water. With this installation a minimum of about 26,000 gpm will be discharged from the 32 acres of water-bearing material within the cofferdams. A possible influx of 65,000 gpm may occur and can be effectively handled by the well-point system set up.

A considerable amount of information is at hand regarding the substrata at the Davis Dam site and regarding the behavior of foundation materials at several other sites on the lower Colorado River. The river-bed materials, however, are not uniform at the Davis site. Although some conclusions can be drawn from at-the-site tests, the answer is still a long way from being accurate. The builder's recourse is to determine in so far as possible the method he will use, and then equip himself so that he will feel safe if the inflows to be handled are 100 to 150 percent above those which his calculations indicate to be probable.

Development of India's Water Resources Provides for Power

(*Continued from page 33*)

Rajamundry in Madras Province. (See CIVIL ENGINEERING for June 1947, page 69.) This structure is estimated to cost $250,000,000 and take eight years to complete. The design has been completed by Indian engineers of the Madras government in consultation with Dr. Savage, and the International Engineering Co. of Denver, Colo. American contractors have already been invited to get in touch with the Madras Public Works Department with regard to construction. It is also anticipated that the major portion of the construction machinery as well as power plants will be obtained from the United States. The dam will be a massive concrete structure, 420 ft high and 6,000 ft long. Excavation for the foundation will total approximately 22,250,000 cu yd, and the structure will involve the placing of 8,020,000 cu yd of concrete. The project is estimated to irrigate 2,000,000 acres of land and generate electricity equal to 100,000 kw, with provision for doubling this output.

Construction has begun on the $150,000,000 Hirakud Dam on the Mahanadi River near Sambalpur in Orissa. The dam will be 150 ft high and three miles long. Six channels extending out from the dam will irrigate over 1,000,000 acres of land. Hydroelectric power amounting to 350,000 kw will be generated.

The multi-purpose Damodar Valley Project is expected to provide perennial irrigation for 800,000 acres and to generate a peak load of 300,000 kw. When this dam is completed, boats will be able to ascend the Hooghly River to the Ramigunj coal field area. About five million people in rural areas and two million in towns are expected to benefit directly from the project. A Damodar Valley Corp. modeled on the TVA is being created to administer operations.

Among other projects are the Tungbhadra (120,000-kw) in Madras Province, the Rihand (250,000-kw) in the United Provinces, and the Bhakra (300,000-kw) in the East Punjab, which together will provide high-level irrigation for approximately 5,000,000 acres.

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SIMPLEX

VALVE AND METER COMPANY

Transportation of Tank Taxes Rail and Highway Facilities

(*Continued from page 23*)

Silver Spring, Md., where the tank was transferred to a 40-wheel trailer supplied by S. & E. McCormick, Inc., construction company of Wilmington, Del., for transportation by highway on the last lap of the journey. Aside from tonnage considerations, transportation problems were further complicated by the tank's structural steel outrigging, which extended about 5 ft on either side. The rigging made it impossible to hoist or roll the tank in unloading, requiring its transfer to be made by easing it or sliding it from the flatcar to the trailer.

When the tank arrived at White Oak, extra rigs and booms were required to remove it from the trailer and place it on a prepared foundation in the Mechanical Test Building, construction of which had been halted pending installation of the tank.

Items ranging in size up to a one-man submarine can be tested in the tank, which will be used to simulate hydrostatic pressures encountered in underwater ordnance. The tank contains guard rails, a hoist, racks and shelves to hold the items undergoing test.

Precast Concrete Units for West Coast Marine Structures

(*Continued from page 50*)

were cast, three right-hand and two left-hand. Their design was quite complex, with curved surfaces, struts, beams and a large number of inserts, sleeves and fittings.

Following the general principles of precast construction, many different types of units were successfully precast and incorporated in the wharf structure. These units included transformer manholes which hung from the deck, conduit troughs, panel forms, and deck slabs with embedded manhole frames and covers. Precast concrete construction permits high-quality structural concrete in the tidal range and below the low-water mark, and avoids the expense and delay of cofferdams.

Piers Constructed for U.S. Navy

In connection with the construction of two large reinforced concrete piers at the San Francisco Naval Shipyard for the U.S. Navy, 14 large transformer vaults were to be constructed under the pier deck. These vaults were approximately 52 ft 6 in. long and either one or two bays (10 or 20 ft) long. Underneath the vaults, the pile cutoff was 2 ft below mean lower low water, and the bottom slabs and walls had to be poured as low as 3 ft below MLLW. The depth of water was 40 ft at these locations and the normal tidal range was 6 ft.

At the contractor's request, the Bureau of Yards and Docks permitted him to precast the vaults, which were floated into position between the pile bents, and hung from transverse beams at the adjacent bents. Several months of valuable time were saved by this procedure. In shallow water inshore a wood pile and timber platform was built from which a heavy bottom form was hung by means of sixteen $2^1/_2$-in.-dia threaded rods. By means of these rods the complete form unit, and later the precast vaults, could be raised and lowered some 10 ft.

North Santiam Highway Follows Difficult Route

(*Continued from page 45*)

Approximately 40 mass-concrete retaining walls are being constructed along steep hillsides to catch fill slopes. Originally planned for masonry construction, the design of these walls was changed when the contractor was unable to secure masons and satisfactory masonry stone.

The importance of continued equipment modernization cannot be overestimated. During the past few years mechanized equipment has evolved to a higher level of efficiency and a broader scope of construction operations. Never before has there been a greater need for close cooperation between equipment manufacturers, contractors and engineers. We are confronted with rising costs and increasing demands for highway modernization. Every reduction in cost means increased funds for the highway program.

The survey, the design, and the construction of the North Santiam Highway has been an onerous task for engineers and contractors. It is recognized as one of the toughest highway jobs ever undertaken in the state, and well deserves the label "unusual." Yet in one respect it shows little difference from other difficult engineering projects of our times. Its problems are being met in the traditional unconcerned yet competent manner that is characteristic of our engineering and construction industry.

Engineering supervision is effected by a force of from 18 to 20 men, consisting of a resident engineer, assistant resident engineer, office engineer, bridge engineer and three field parties. These men are housed in a temporary, though modern, camp constructed by the Corps of Engineers. The project was designed, and its construction is being supervised by Division No. 8 of the Public Roads Administration with headquarters at Portland, Ore.

Mammoth Earthmoving Job for San Francisco Airport

(*Continued from page 54*)

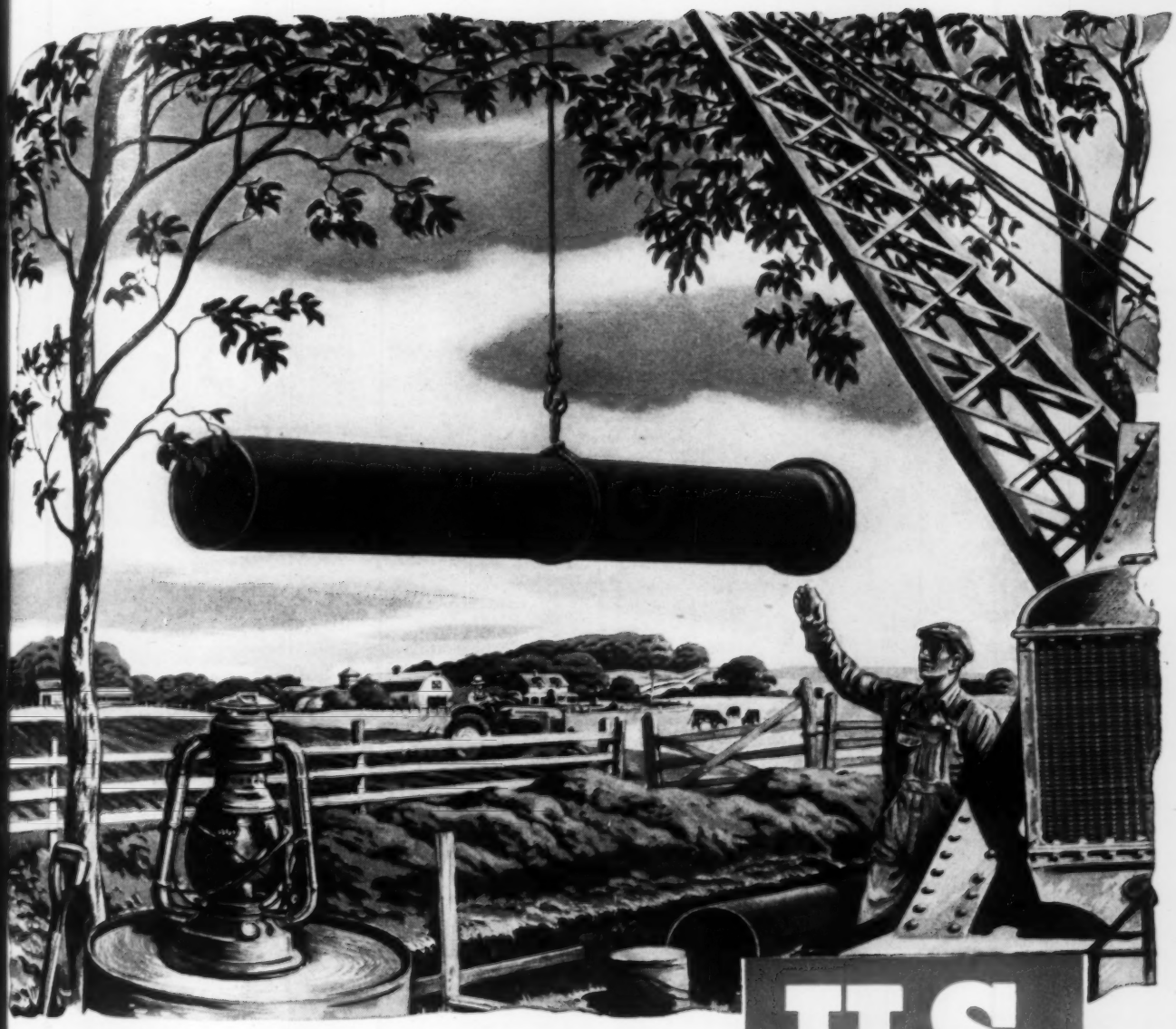
tractors with 16.3-cu yd Dixson wagons of the clamshell type had been secured. The wagons had not been job tested before and this contract was a proving and an improving ground for them. A supplementary fleet consisted of 39 conventional bottom-dump trucks, Euclids of 13-yd capacity. The trucks, especially the newer models with General Motor diesels, which could be built up to 17 cu yd, were satisfactory but on this long haul simply did not pack enough load. The slower Euclids were always in the way of the faster Euclids and the Peterbilt trucks.

Dumping and Spreading. The material from the bottom-dump trucks was windrowed and handled by Caterpillar dozers. If the material was going over the edge of the fill on to San Francisco Bay mud, the dozers pushed it over the bank in 7- to 10-ft lifts. If the material was to be used for raising the grade of the airport, it was spread in 8-in. lifts.

Supervisory Organizations. Each shift had a superintendent in charge under the writer's general supervision. Each shift had a pit foreman, a truck foreman, and a fill foreman. A master mechanic, responsible to the writer and in charge of the entire equipment spread, had under him a shop foreman in charge of shop repairmen on each shift.

Another Contract

Before completion of the 6,000,000-cu yd airfield contract, the State of California asked for bids on five miles of freeway construction on which the same "joint venture" was the low bidder. This contract called for the furnishing of 3,100,000 tons of imported fill material. The source of material was the same but the haul was longer. Toward the end of the 6,000,000-cu yd contract, the two contracts were worked in conjunction. It was necessary to install scales to weigh the truck loads and the empties were weighed once a shift, but otherwise the operation was the same.



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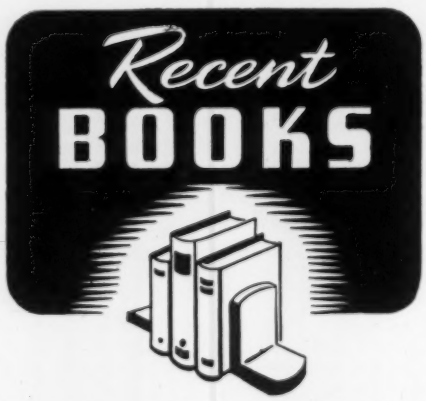
Construction of Two New San Francisco Bay Crossings

(*Continued from page 39*)

Designs for all structures are being carried to the point where a reasonable estimate of cost can be made. Completion of the design work will also permit a fair estimate of the time necessary for construction and of any possible shortage of critical materials and skilled labor.

In addition to the staff of engineers assembled in San Francisco, a board of outstanding consultants has been retained. This board includes Ralph Smillie, M. ASCE, chief engineer of the Triborough Bridge and Tunnel Authority, who will advise specifically on subaqueous tunnels; George L. Freeman, M. ASCE, consulting engineer of New York, N.Y., who will advise particularly on foundation problems; and O. J. Porter, M. ASCE, consulting engineer of California and New York, who will advise on soil mechanics problems. The firm of Coverdale and Colpitts of New York has been retained to make an independent study of traffic and to estimate future revenue that may be expected from the additional and existing crossings.

It is contemplated that the current studies will be completed early in the fall of 1948, and that a recommendation can be made to the Department of Public Works and the Toll Bridge Authority before the end of the year. When a decision is reached by the Authority, the work of preparing contract plans and specifications can proceed, and when financing is accomplished construction can start. Barring unforeseen difficulties it is reasonable to expect that construction can start in 1950 and be completed three years later.



ASTM STANDARDS ON CEMENT (with Related Information), prepared by ASTM committee C-1 on Cement; Specifications, Chemical Analysis, Physical Tests. January 1948. American Society for Testing Materials. 1916 Race St., Philadelphia, Pa., 1948. 191 pp., illus., diagrs., tables, 9 × 6 in., paper, $2.; $1.50 to members. Presenting seven specifications for portland and other types of cement, this volume also gives fifteen standard methods of testing. It contains considerable supplementary material including information on analytical balances and weights, a manual of cement testing, a list of selected references on portland cement, the principle of the methoxyl method for determining vinsol resin in portland cement, and a proposed method of test for setting time of hydraulic cement in mortar.

PLANNING INDUSTRIAL STRUCTURES. By C. [illegible] Dunham. McGraw-Hill Book Co., New York, Toronto, London, 1948. 481 pp., illus., diagrs., charts, tables, 9¼ × 6 in., cloth, $6. Serving as an introduction to structural engineering, this book deals with the principles and planning of structures that precede numerical calculations. It considers the choice of materials and general type of construction along with a discussion of good practice in building with steel, wood, and concrete. The basic action of structures, especially those used in industrial construction, is treated. Many examples of construction are illustrated.

SURVEY OF PERSONNEL PRACTICES IN LOS ANGELES COUNTY as of August 1, 1947, Bulletin No. 1[illegible] Compiled by R. O. Sensor and M. F. Martin. California Institute of Technology, Industrial Relations Section, Pasadena 4, Calif. 45 pp., tables, 11 × 8½ in., paper, $2.50. This condensed study covers work schedules, premium pay, incentive pay plans, wage schedules, job evaluation plans, holiday pay, shift differentials, and union representation. The information is presented in the form of detailed tables, and directions for the effective use of the data are given in the introduction.

ELEVEN AND FIFTEEN-PLACE TABLES OF BESSEL FUNCTIONS of the First Kind, to All Significant Orders. By E. Cambi. Dover Publications, 1780 Broadway, New York, 1948. 154 pp., tables, 10¾ × 8 ½ in., cloth, $3.95. The main tables give $J_n(x)$ for x ranging from 0 to 10.5 at intervals of 0.01, to eleven places. Supplementary tables give $J_n(x)$ for x ranging from 0 to 0.500 at intervals of 0.001, to 15 places, and Taylor Series for J_n of even order for $x = 2$ to 10, inclusive. The introduction contains an explanation of the tables and graphs which show their accuracy.

HYDRAULIC MACHINERY. By S. R. Beitler and E. J. Lindahl. Irwin-Farnham Publishing Co., Chicago, Ill., 1947. 217 pp., illus., diagrs., charts, tables, 9¼ × 6 in., cloth, $3.50. Based on a course in hydraulic machinery for upper class students in mechanical engineering, this volume describes briefly the theory and practice of a variety of apparatus. Following a review of the fundamentals of the subject are chapters dealing with pipes, meters, weirs, flumes, pumps and turbines. Compressible fluid flow and fluid drives are also considered. Problems are found at the end of each chapter.

CHANGES IN MEMBERSHIP GRADES

ADDITIONS, TRANSFERS, REINSTATEMENTS, AND RESIGNATIONS

From June 10 to July 9, 1948

Additions to Membership

ABRAHAM, JAMES GLADSTONE (Assoc. M. '48) Deputy Chf. Engr. (Gen.), Public Works Dept., Chapauk (Res., 10 Chinna Reddy St., Egmore), Madras, India.

AINSLIE, GEORGE WARREN, JR. (Jun. '48) Junior Hydr. Engr., U.S. Geological Survey, Dept. of Interior, 531 Federal Bldg. (Res., 1918 Eastview Ave.), Louisville, Ky.

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ALLEN, STUART EDWARD (Jun. '48) Engr. Mapper, Revaluating Property, The George B. Horan Co., 207 Orange St., New Haven (Res., Care, Skau Camp, Madison), Conn.

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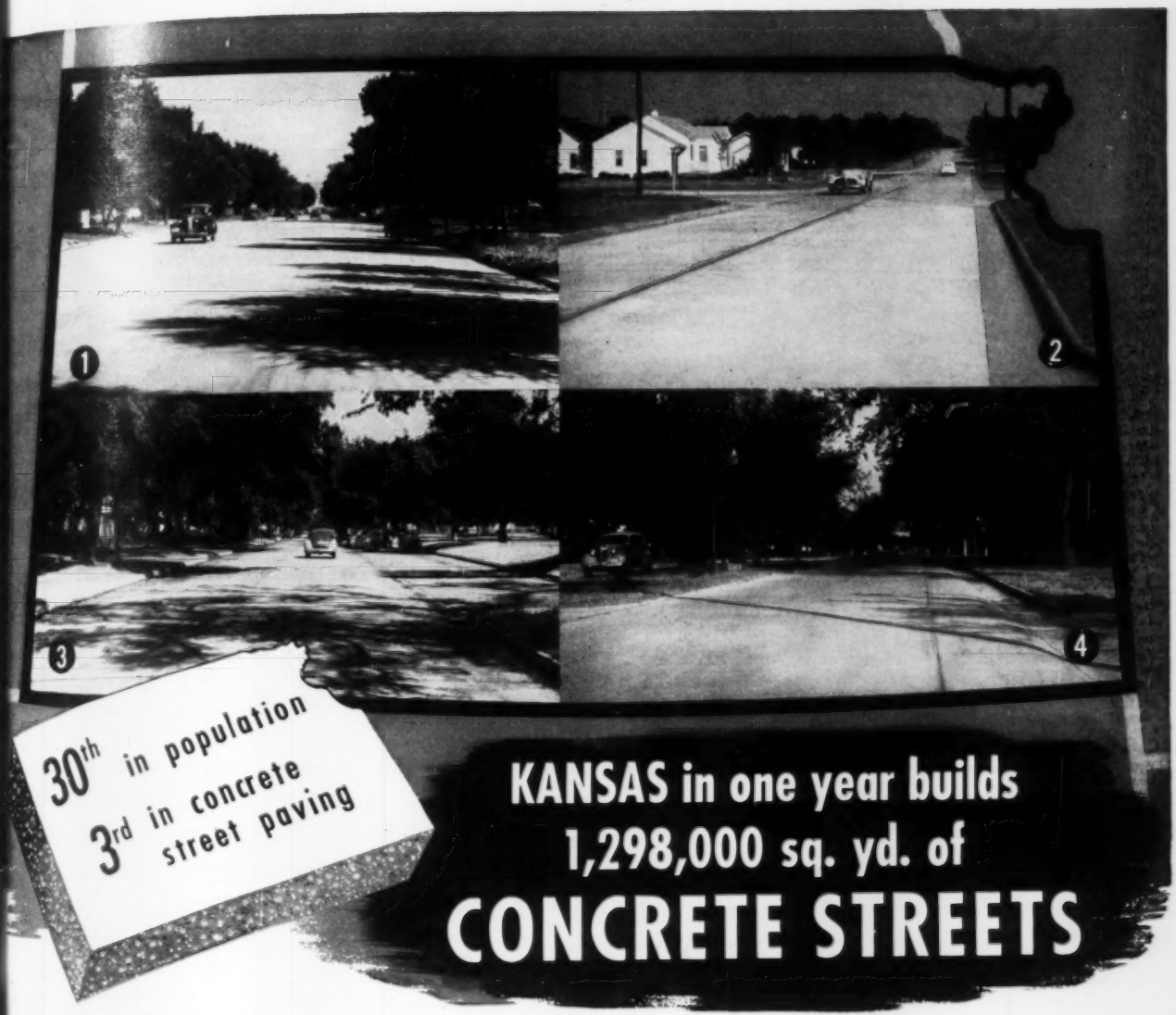

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•

1 Main St., Atwood. With population of about 1,500, Atwood scheduled 42,200 sq. yd. of concrete streets in '47.

2 Newly-built 5th St., Russell — part of 13,290 sq. yd. concrete street paving program undertaken during 1947.

3 Kansas Ave., Wichita, showing parking bays at right for park visitors. Wichita contracted for 264,512 sq. yd. of concrete street paving in 1947.

4 Broadway Ave., Great Bend, showing completion of concrete resurfacing project.

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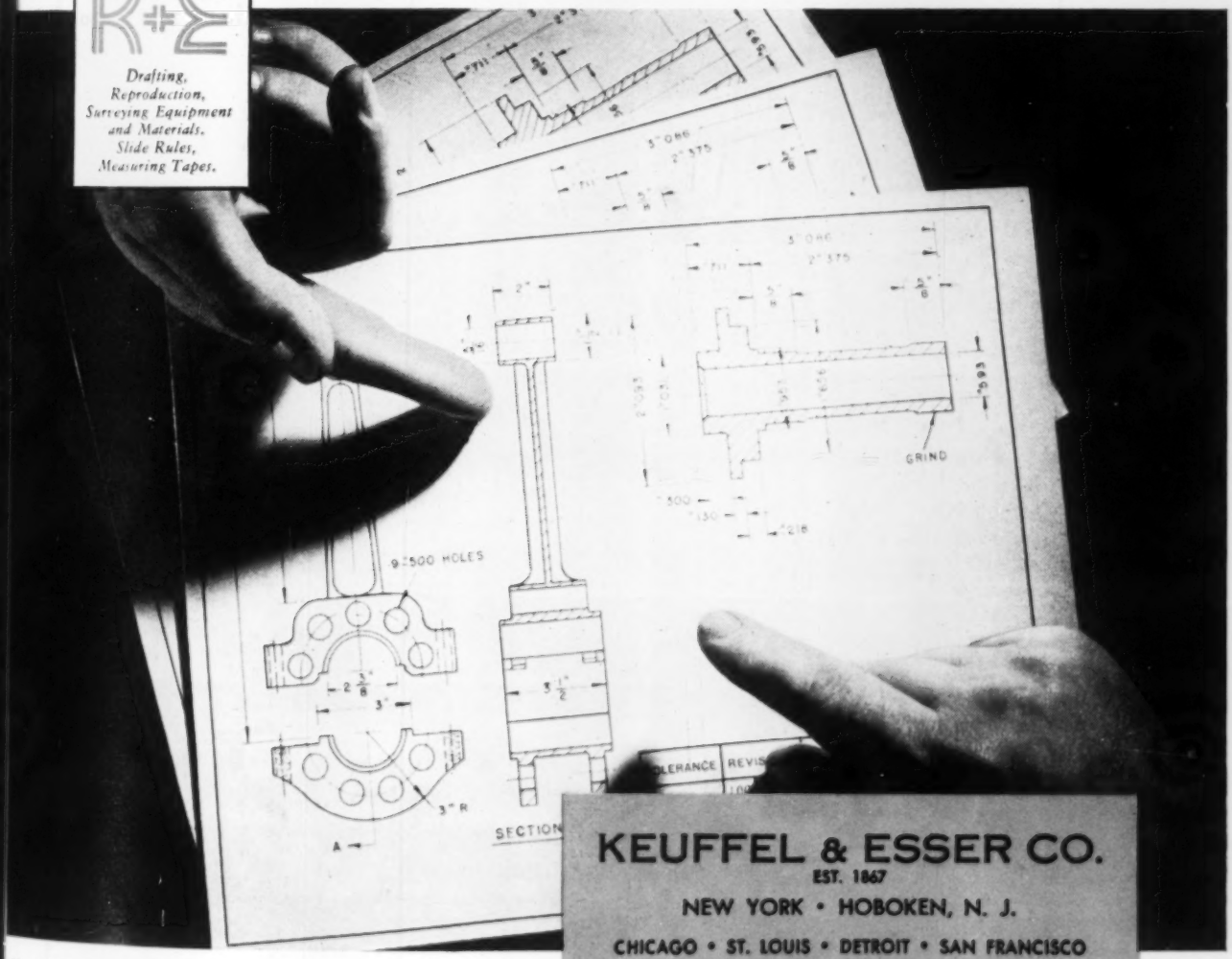

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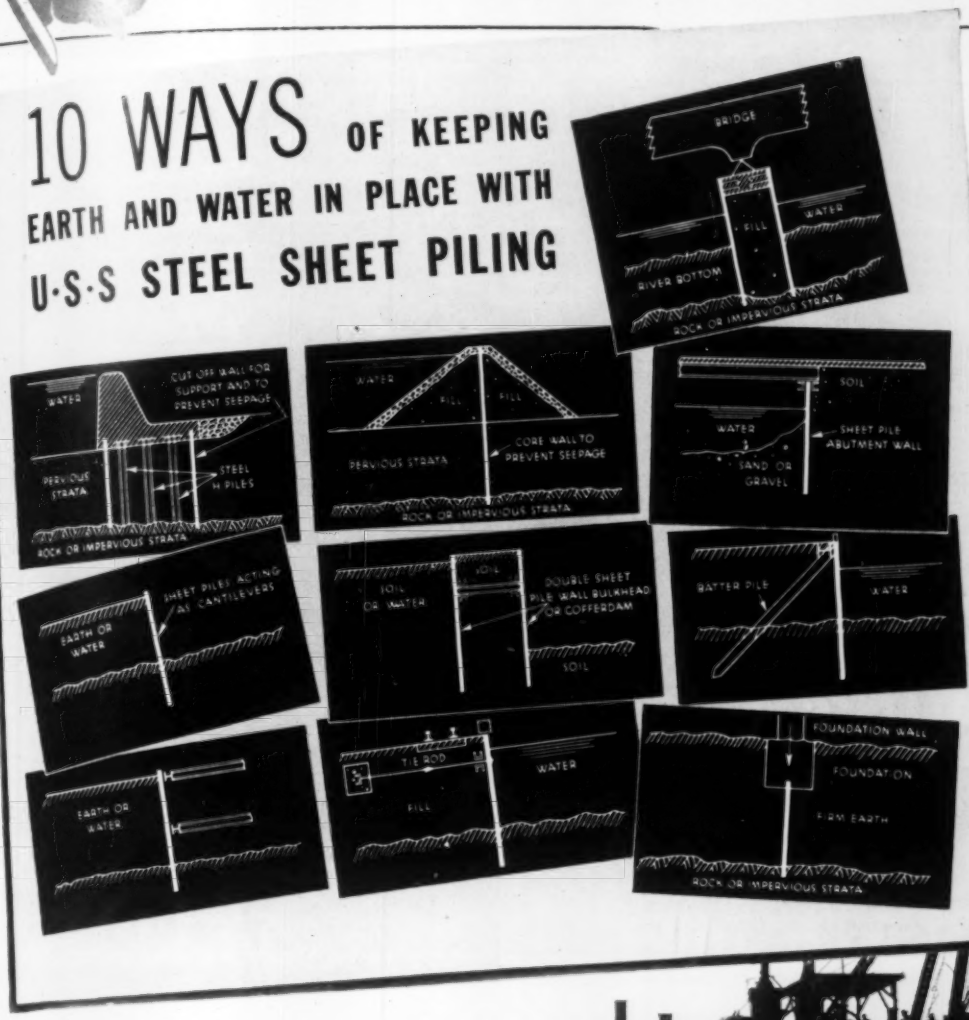

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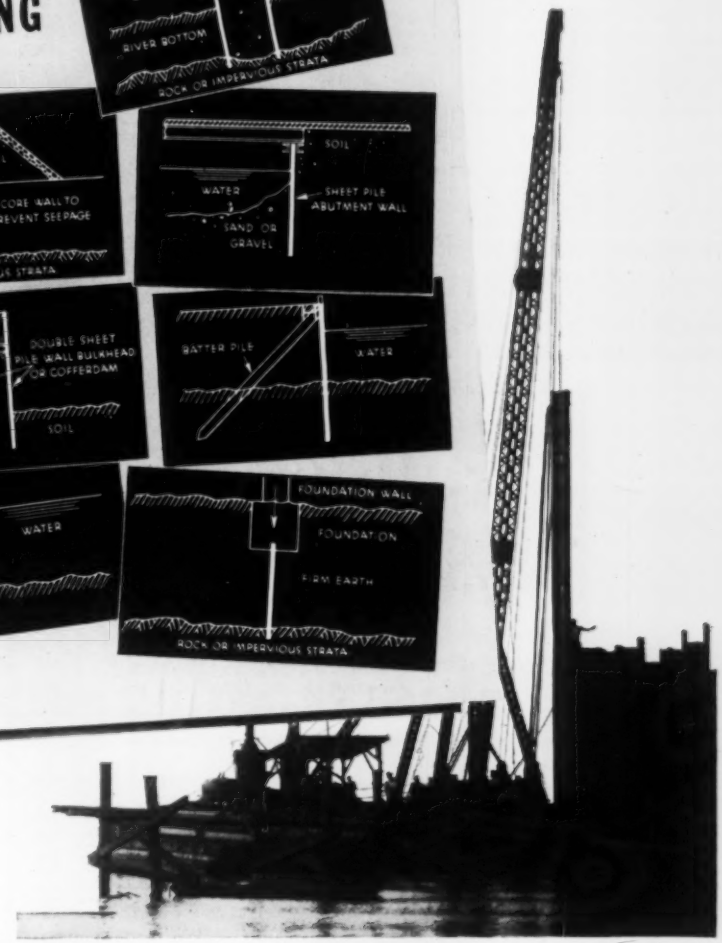

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'48) Asst. Chf. Engr., Marin Municipal Water Dist., San Rafael, Calif.

SCOTT, HAROLD AUSTIN, SR. (Assoc. M. '43; M. '48) Chf. Multiple Purpose Reports, Corps of Engrs., Dept. of Army, P.O. Box 4970 (Res., 4134 Dover Road), Jacksonville 7, Fla.

STORMS, RICHARD EDWARD (Jun. '35; Assoc. M. '48) Pres. and Mgr., Concrete Materials, Inc., Box 269, Morristown, Tenn.

TEUFEL, GEORGE ILLINGSWORTH (Jun. '34; Assoc. M. '48) Supt., Geo. E. Teufel Co., 4451 White Henry Stuart Bldg. (Res., 10850 Lakeridge Drive), Seattle 1, Wash.

TIPPY, KENNETH CLEM (Assoc. M. '38; M. '48) Prof. of Civ. Eng. and Head of the Dept., Univ. of Connecticut, Box U-37, Stoors, Conn.

WARNER, ROY FERDINAND (Jun. '35; Assoc. M. '39; M. '48) Vice-Pres., Nord-Warner Co., 118 North Concord, South (Res., 1872 North Howard), St. Paul 9, Minn.

WHITTAKER, JOHN DEAN (Jun. '36; Assoc. M. '48) Maj., Royal Canadian Engrs., Dept. of National Defense (Res., 64 Aylmer Ave.), Ottawa, Canada.

WILLIAMS, THOMAS WILLIAM (Assoc. M. '25; M. '48) Engr., Eng. Div., City of New Bedford, Municipal Bldg. (Res., 415 County St.), New Bedford, Mass.

Reinstatements

ABBOTT, DONALD, Assoc. M., Engr., U.S. Atomic Energy Comm., 1901 Constitution (Res., 3112 Q St. N.W.), Washington 7, D.C., readmitted June 7, 1948.

BURKLIN, WILLIAM BOYD, Assoc. M., Dist. Civ. Engr., Humble Oil & Refining Co., Encino, Tex., readmitted May 4, 1948.

DOUGLAS, WALTER SPALDING, M., Associate, Parsons, Brinckerhoff, Hogan & Macdonald, 142 Maiden Lane, New York, N.Y., readmitted May 4, 1948.

FRANKLIN, GEORGE EDWARD, Assoc. M., Senior Engr., City of Dallas, Main & Harwood (Res., 5027 Mission Ave.), Dallas, Tex., reinstated June 1, 1948.

GOEHRING, FRANK ELDON, Assoc. M., 930 Broadway, Bend, Ore., readmitted Dec. 10, 1947.

GREEN, ROBERT LOWELL, Jun., Lecturer in Civ. Eng., Univ. of California, Berkeley, Calif., reinstated June 11, 1948.

HAMMOND, NEWTON LEROY, M., Dept. Engr., Board of Water Supply, City of N.Y., Roscoe, N.Y., reinstated June 17, 1948.

HITEMAN, LESLIE HENRY, Assoc. M., Assoc. Hydr. Engr., American Gas Assn., Amarillo Helium Plant (Res., 1019 Travis St.), Amarillo, Tex., readmitted Jan. 12, 1948.

JACKSON, ROBERT JAMES, JR., Jun., Engr. Advisor on Airfield Constr., The Venezuelan Air Force, Care Military Attaché, American Embassy (Res., Ave. Los Samanes No. 5, LaFlorida), Caracas, Venezuela, reinstated June 15, 1948.

LYONS, WILLIAM THEODORE, Assoc. M. (The William T. Lyons Co. Inc.), 1001 Tower Bldg., Baltimore 2, Md., reinstated June 15, 1948.

MCDILL, WILLIAM HOWARD, Assoc. M., Asst. Prof. of Eng., Texas College of Mines & Metallurgy (Res., 2211 N. Stanton St.), El Paso, Tex., readmitted Apr. 12, 1948.

OLIVER, FRANK GILLESPIE, Assoc. M., Sales Engr., Austin Bros., 1815 Coombs St. (Res., 4333 Emerson), Dallas, Tex., readmitted May 4, 1948.

QUENTIN, WILLIAM JOHN, Assoc. M., 2123 Eye St. N.W., Washington, D.C., reinstated June 21, 1948.

RICE, WILLIAM THOMAS, Assoc. M., Supt., Richmond, Fredericksburg & Potomac R.R. Co., Alexandria, Va., readmitted Mar. 15, 1948.

ROBINSON, ONSLOW STEWART, Assoc. M. (Onslow S. Robinson) Civ. Engr., R.F.D., West Tisbury, Mass., reinstated June 28, 1948.

WELLS, WILLIAM GORDON, Assoc. M. (Brown Wells & Meagher), 1181/2 West Campbell Ave., Roanoke, Va., reinstated June 10, 1948.

Resignations

BOYER, PETER BOYAJIAN, Assoc. M., 2724 North East Dunckley, Portland, Ore., resigned Apr. 2, 1948.

GODDARD, GROVER CLEVELAND, JR., Jun., 952 East Wyomino St., Ocala, Fla., resigned June 24, 1948.

HODGES, EDWARD BONNEAU, Jun., Box 706, Statesville, N.C., resigned Apr. 13, 1948.

KALAJIAN, HARRY, Jun., 165 Fifty-ninth St., West New York, N.J., resigned Apr. 13, 1948.

SNYDER, PHILIP NATHAN, Jun., 109 Charles St., Greeneville, Tenn., resigned June 18, 1948.

APPLICATIONS FOR ADMISSION OR TRANSFER

August 1, 1948 — Number 8

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every Member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid it in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board. Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

GRADE	GENERAL REQUIREMENT	AGE	LENGTH OF ACTIVE PRACTICE	RESPONSIBLE CHARGE OF WORK
Member	Qualified to design as well as to direct important work	35 years	12 years	5 years
Associate Member	Qualified to direct work	27 years	8 years	1 year
Junior	Qualified for subprofessional work	20 years	4 years	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years	5 years

APPLYING FOR MEMBER

ALI, HAKIM (Age 45) Dean, Faculty of Eng., Dacca Univ., East Bengal, Pakistan.

BARNETT, NALLIE BECKHAM (Assoc. M.) (Age 47) Civ. Engr. (Chief), P-5, Eng. Dept., U.S. Naval Ammunition Depot, Shumaker, Ark.

BIRD, CYRUS REMINGTON (Assoc. M.) (Age 55) Vice-Pres. and Western Mgr., The Pitometer Co., Engrs., Chicago, Ill.

BLUME, JOHN AUGUST (Assoc. M.) (Age 39) Cons. and Designing Structural and Civ. Engr., San Francisco, Calif.

BOLLMAN, LESLIE WEBER (Assoc. M.) (Age 39) Asst. Civ. Engr., New York City Board of Water Supply, Merriman Dam, Lackawack, N.Y.

BUTLER, SOULE (Age 45) City Engr. (City Hall), Alexandria, Va.

CARROLL, EDWARD WILLISON (Age 62) County Engr., Hillsborough County, Tampa, Fla.

DAVIS, RICHARD ORRICK (Age 46) Project Engr., Virginia Bridge Co., Birmingham, Ala.

EVERHAM, ARTHUR THOMPSON (Assoc. M.) (Age 39) Asst. Mgr., Midwestern Contrs., Inc., Chicago, Ill.

GARDE, VINAYAK GOVIND (Assoc. M.) (Age 48) Prof. of Civ. Eng., Thomason Coll. of Eng., Roorkee, India.

HARTMAN, HARRY FRANKLIN (Age 43) Head, Eng. Div., Bayton Refinery, Bayton, Tex.

HOLMSTROM, HELMER AUGUST (Assoc. M.) (Age 38) Lt. Col., Corps of Engrs., U.S. Army, Div. Engr., 25th Inf. Div. Area, Japan.

JACKSON, ROBERT AUSTIN (Jun.) (Age 35) Sales and Contr. Engr., Chicago Bridge & Iron Co., Tulsa, Okla.

JENSEN, KNUD HOVGAARD (Age 47) Chf. Engr. with Frank D. McEnteer, Clarksburg, W.Va.

JONES, VALENS (Age 44) Engr. P-3, U.S. Bureau of Reclamation, Denver, Colo.

KOCH, EDWARD FRANCIS (Age 38) Superv. Engr., U.S. PRA, Jefferson City, Mo.

LANE, THOMAS ALPHONSUS (Age 41) Col., U.S. Army, Maxwell AF Base, Montgomery, Ala.

LUCKENBACH, RALPH BLAISDELL (Age 47) Dist. Traffic Engr., Dist. XI, California Dist. of Highways, San Diego, Calif.

MAHOOD, HARRY SAMUEL (Age 54) Chf. Res. Engr., Inspector, Power Div., FWA, North Platte, Nebr.

MARYE, EDWARD AVONMORE (Assoc. M.) (Age 46) Member of firm, Meriwether, Marye & Associates, Lexington, Ky.

MILNER, WALKER WILSON (Assoc. M.) (Age 40) Lt. Col., Gen. Staff Corps, Corps of Engrs., Plans & Operations Div., U.S. Army, Washington, D.C.

MINASIAN, JOHN KACHIG (Jun.) (Age 34) Cons. Civ. Engr. (member of firm, Johnson & Minasian), Los Angeles, Calif.

NORTON, JOHN COMSTOCK (Assoc. M.) (Age 37) Senior Structural Engr., Smith, Hinchman & Grylls, Inc., Detroit, Mich.

PALMORE, WILLIAM ROBERT, JR. (Age 47) Asst. Div. Engr. (Constr.), Alabama Highway Dept., Tuscaloosa, Ala.

REEVES, JAMES EDSON (Assoc. M.) (Age 41) U.S. Dist. Engr. Office, AMAG, Athens, Greece.

RIGGAN, LOUIS NAPOLEON (Age 58) Engr. of Constr., Seaboard Airline Ry. Co., Norfolk, Va.

ROBBINS, JAMES MELVIN (Assoc. M.) (Age 46) Associate Prof. of Civ. Eng., Executive Associate, Dept. of Civ. Eng., Newark Coll. of Eng., Newark, N.J.

ROGERS, CHESTER W. (Age 58) Asst. Div. Engr., Alabama Highway Dept., Tuscaloosa, Ala.

SCHRAM, IRWIN HERBERT (Age 60) Chf. Engr., R.R. System, Cleveland, Ohio.

SPANN, GEORGE (Age 43) Div. Engr., New York City Board of Water Supply, Grahamsville, N.Y.

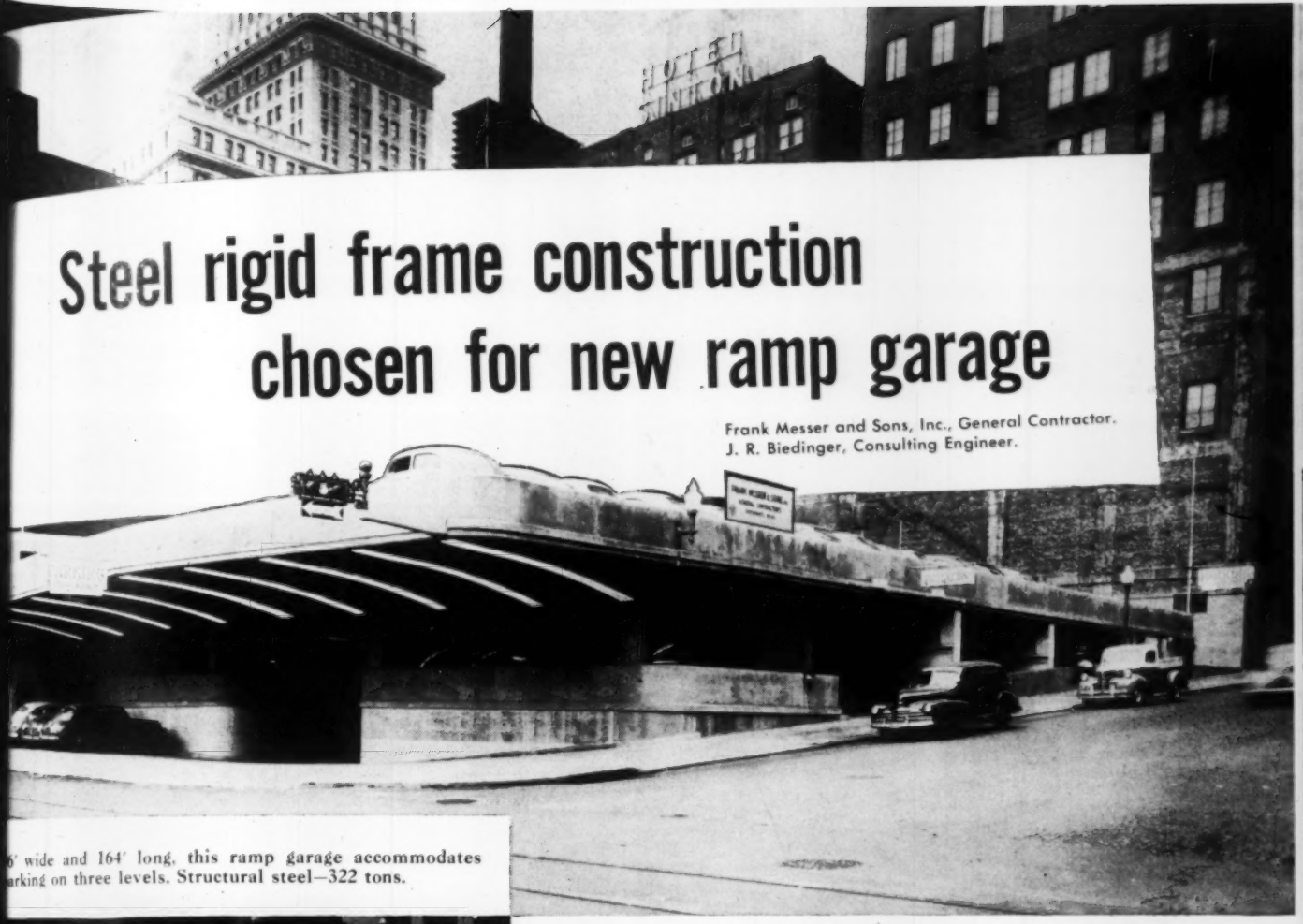
STEWART, GEORGE CAMBRELENG (Assoc. M.) (Age 40) Civ. Engr., New York City Board of Water Supply, Chelsea, N.Y.

STILLWELL, HOWARD LOGAN (Age 58) Cons. Engr., Dickson & Stillwell, Engrs., Charlotte, N.C.

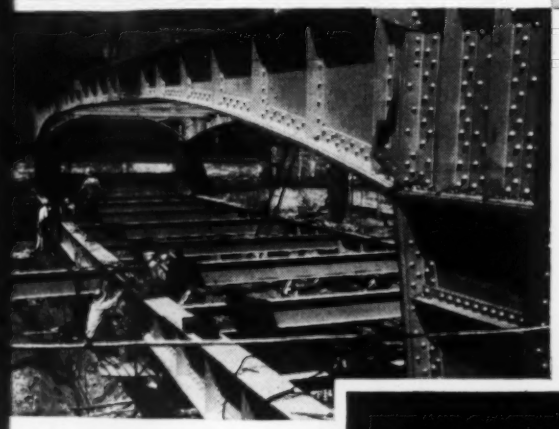
THEILL, KAJ (Assoc. M.) (Age 48) Cons. Engr., San Francisco, Calif.

Steel rigid frame construction chosen for new ramp garage

Frank Messer and Sons, Inc., General Contractor.
J. R. Biedinger, Consulting Engineer.



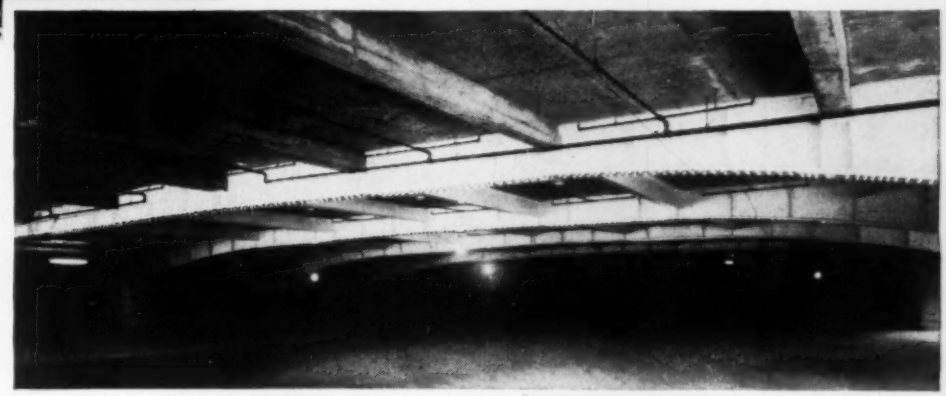
6' wide and 164' long, this ramp garage accommodates arking on three levels. Structural steel—322 tons.



l frames are of riveted plate and e construction, 96' c.c. of bearings.

STEEL rigid frame construction has given this ramp garage increased vehicle capacity by eliminating the columns found in some other types of garage construction. Erected by American Bridge Company in Cincinnati, Ohio, this garage is typical of a new trend in garage design and construction.

With the growing need for traffic planning, structures such as this are becoming increasingly important. To help you take full advantage of steel in this type of construction, American Bridge Company places its experience and facilities for fabrication and erecting at your service. We suggest that you contact our nearest Contracting Office.



osts to reduce size of parking area ause inconveniences here! Little er that this "postless" type of garage truction is becoming more and more lar.

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UNITED STATES STEEL

TRAHERN, JAMES WILLIAM (Assoc. M.) (Age 50) Supv. Civ. Engr., East Bay Municipal Utility Dist., Oakland, Calif.

WELSH, JOHN GRAHAM (Age 37) Bridge Designer, Roads Dept., Cape Provincial Administration, Cape Town, South Africa.

WESTENHOEF, ALPHONSE MUELLER (Assoc. M.) (Age 56) Engr. of Constr., New York Central System, West of Buffalo, Chicago, Ill.

WILLIG, WALTER LEE (Assoc. M.) (Age 46) Asst. Prof. of Civ. Eng., Coll. of City of New York; Portchester, N.Y.

WOOD, ROBERT WILLIAM (Age 66) Engr., Chf., Air Installations, Strategic Air Command, USAF, Washington, D.C.

APPLYING FOR ASSOCIATE MEMBER

ALTENHOFEN, MATTHEW JOHN (Jun.) (Age 32) Lt. Col., Corps of Engrs., U.S. Army, East Orange, N.J.

AUSTIN, ROBERT DALE (Jun.) (Age 34) Engr. P-4, U.S. Bureau of Reclamation, Yuma, Ariz.

BAIRD, MAURICE MARVIN (Jun.) (Age 34) Partnership with Theodore M. Kuss, Cons. Engr., San Francisco, Calif.

BARKIN, MEYER JOSEPH (Age 39) Asst. Sec. Engr., New York City Board of Water Supply, Margaretville, N.Y.

BENE, JOHN (Jun.) (Age 35) City Engr., Helper, Utah; Dist. Engr., Price River Conservancy Dist.; County Engr., Carbon County; Cons. Engr., Price City, Utah.

BLANCK, WILLIAM AUGUSTUS (Age 48) Jun. Engr., New York City Board of Water Supply, Kerhonkson, N.Y.

BRUCE, ROBERT HAROLD (Jun.) (Age 34) Topographic Engr., U.S. Geological Survey, Sacramento, Calif.

CARL, KENNETH JOHN (Jun.) (Age 35) Engr., National Board of Fire Underwriters, Baldwin, N.Y.

CHOW, LI HSIANG (Age 29) Engr. with E. J. Muller, Norwegian Civ. Engrs., Shanghai, China.

CORTRIGHT, DONALD NATHAN (Jun.) (Age 34) Instructor in Civ. Eng., Washington Univ., St. Louis, Mo.

COSTELLO, FRANK (Age 54) Asst. Civ. Engr., New York City Board of Water Supply, White Plains, N.Y.

DEL ROSARIO, RAMON V. (Age 37) With Eng. Div., Manila Engr. Dist., Manila, Philippine Islands.

DENNIS, WILLIAM JOHN (Age 41) Asst. Soils Engr., Dist. 5, New York State Dept. of Public Works, Hamburg, N.Y.

DONOVAN, RICHARD JULIAN (Jun.) (Age 31) Engr., F. H. Whelan Co., Boston, Mass.

DRAKE, HARRY LAURIN (Jun.) (Age 35) Engr. P-3, Corps of Engrs., Dept. of Army, Dist. Office, Tulsa, Okla.

DULBERG, SAMUEL SAUL (Age 40) Asst. Bridge Engr., California Div. of Highways, Long Beach, Calif.

FEILER, ALFRED MARTIN (Jun.) (Age 28) Asst. Prof. of Civ. Eng., Director of Fluid Mechanics, Syracuse Univ., Syracuse, N.Y.

GOLDENTHAL, MITCHEL (Jun.) (Age 28) Major, Corps of Engrs., U.S. Army, Post Engr., Munich Mil. Post.

GOODIN, JOHN VANDIVER (Age 35) Civ. Engr. Corps of Engrs., War Dept., Memphis, Tenn.

HARTMAN, LOUIS FREDERICK (Age 35) Design Engr., Standard Oil Co., Ind., Sugar Creek, Mo., Independence, Mo.

HAYWARD, CARL BURTON (Age 27) Designing Engr. with Damon Runyan, Cons. Engr., Longmont, Colo.; Kansas City, Mo.

HELVERSEN, FREDERICK DOUGLAS (Jun.) (Age 34) Div. Industrial Engr., Western Waxed Paper Co., Div. of Crown Zellerbach Corp., Los Angeles, Calif.

HEYNIGER, PAUL WILLIAM (Age 36) 3½ years with U.S. Army; previously Civ. Engr., Wigton-Abbott Corp., Contrs., Plainfield, N.J.

HINGSTON, CHARLES EDWARD (Age 40) Asst. Engr., Metropolitan Transit Authority, Boston, Mass.

HUTCHINSON, SYLVANUS NYE (Age 41) Res. Engr., Chesapeake & Ohio Ry., Huntington, W.Va.

JESPERSEN, ERIK FRIIS (Age 27) Designer and Draftsman, Pacific Islands Engrs., Guam, Guam.

JONES, CHESTER WARREN (Jun.) (Age 34) Engr. P-3 (Materials), U.S. Bureau of Reclamation, Denver, Colo.

KASSER, RICHARD CONNOR (Jun.) (Age 34) Head, Constr. Sec., Development Div., Aluminum Co. of America, Oakmont, Pa.

KELLEY, ROY SKILES (Age 32) Lt. Col., Corps of Engrs., U.S. Army, Bowling Green, Ky.

KENNEDY, CHARLES E. (Age 46) Asst. Civ. Engr., New York City Board of Water Supply, Mt. Kisco, N.Y.

KIMBALL, JACK HAVEN (Jun.) (Age 35) Dist. Mgr., Board of Trustees, Orange County Mosquito Abatement Dist., Santa Ana, Calif.

LARSON, MARVIN ARTHUR (Age 31) 1948 graduate; previously with U. S. Army and U. S. Engr. Dept. Fairbanks, Alaska.

MCKINLEY, RUSSELL EDWARD (Age 42) 1948 B.S.C.E., Univ. of Utah; previously Assayer & Asst. Clerk, Rock Asphalt Co. of Utah, Sunnyside, Utah.

MCNEAL, JOHN, 3d (Age 37) Land Surveyor (private practice), Easton, Pa.

MCNUTT, RUSSELL ALTON (Age 34) Office Engr., Raymond Concrete Pile Co. of Venezuela, Caracas, Venezuela.

MAGNUSON, MARSHALL CONRAD (Age 35) Senior Structural Designer, Ford, Bacon & Davis, Inc., Chicago, Ill.

MAIER, NEWMAN DOUGLAS (Jun.) (Age 34) Engr.-Designer, South Coast Corp., Houma, La.

MINNOTTE, JACQUE SEARS (Jun.) (Age 34) Engr. P-4, War Dept., Corps of Engrs., Pittsburgh, Pa.

MIRSKY, ARON LEON (Age 32) Jun. Highway Engr., Bridge Design Sec., Connecticut Highway Dept., Hartford, Conn.

MULLER, WALTER NICHOLAS (Age 41) Draftsman, New York City Board of Water Supply, Ellenville, N.Y.

MUZYKA, ANDREW (Age 36) Mathematician, U.S. Coast & Geodetic Survey, New York City.

NAGEL, CHARLES (Age 31) Asst. Civ. Engr., New York City Board of Water Supply, Grahamsville, N.Y.

NELSON, GEORGE WILLIAM (Age 43) Laboratory Technician, Univ. of Southern California, Los Angeles, Calif.

O'ROURKE, GEORGE PAUL, JR. (Jun.) (Age 29) Structural Engr. and member of firm, O'Rourke Constr. Co., Dallas, Tex.

RASHID, MOHAMMAD ABDUR (Jun.) (Age 29) With Public Works Dept., Assam, India Post. Gochapara, Dist. Sylhet, East Pakistan.

REID, ROBERT LOCKHART (Age 32) Cons. Engr., Joske's of Houston, Turbiville Motors, etc., Houston, Tex.

ROHDE, CARL (Jun.) (Age 35) Engr. P-4, Corps of Engrs., Dept. of Army, Portland, Ore.

ROOS, WILLIAM FREDERICK (Age 29) Capt., Corps of Engrs., U.S. Army, Salt Lake City, Utah.

SACHS, MILTON SAMUEL (Age 44) Hydr. Engr., Bureau of Reclamation, Region 1, Boise, Idaho.

SALINAS, EDMOND THIEBAUD (Age 39) Mun. & Chf. Engr. of Streets, La Ceiba, Honduras; at present graduate student, Iowa State Coll., Ames, Iowa.

SAMUEL, CHARLES FREDERICK (Age 39) Asst. Engr., Black & Veatch, Kansas City, Mo.

SCHMITT, EDWARD FRANCIS (Age 45) Asst. Civ. Engr., New York City Board of Water Supply, Ellenville, N.Y.

SEIP, CHARLES STUART (Age 42) Asst. Civ. Engr., New York City Board of Water Supply, Downsville, N.Y.

SREENIVASAN, AMURTUR RAMANUJAN (Age 42) Officer in Charge, Tech. Sec., Office of Chf. Engr. of Irrigation, Madras, India.

STEPHENSON, GERARD JAMES (Age 42) Jun. Civ. Engr., New York City Board of Water Supply, Downsville, N.Y.

SNOW, DEWITT MILLS (Jun.) (Age 34) Structural Engr., Brown-Pacific-Maxon, Navy Constrs., San Francisco, Calif.

STIVERS, THEODORE PAUL (Jun.) (Age 32) Chf. Engr. and Gen. Supt. of Dist., South San Joaquin Irrigation Dist., Manteca, Calif.

THOMPSON, MERRILL RONE (Age 48) Asst. Civ. Engr., New York City Board of Water Supply, Downsville, N.Y.

VALLE-RODAS, RAUL (Jun.) (Age 32) Cons. Engr., Materials Testing Laboratory, Ministry of Public Works of Venezuela, Caracas, Venezuela.

WANG, MING YUNG (Age 29) Engr. with E. J. Muller, Norwegian Civ. Engrs., Shanghai, China.

WILSON, VERNE GEORGE (Jun.) (Age 35) Senior Engr., Kimberly-Clark Corporation, Development Group, Lakeview Hill Eng. Dept., Neenah, Wis.

YARAR, RIFAT (Age 35) Asst. Prof., Structures and Reinforced Concrete, Tech. Univ., Istanbul, Turkey; graduate student, Harvard Univ., Cambridge, Mass.

APPLYING FOR JUNIOR

ALLEN, MAX HAROLD (Age 23) Asst. Public Works Officer, Naval Air Station, Navy 14, FPO, San Francisco, Calif.

BETTERS, RAYMOND JOSEPH (Age 30) Engr., Morrison Constr. Co., Inc., Gary, Ind.

CANADA, RAYFORD REED (Age 24) Structural Draftsman, Mosher Steel Co., Dallas, Tex.

HUSSAIN, MAHMOOD (Age 26) Govt. of India Engr. Trainee, Bureau of Reclamation, Denver, Colo.

LEA, NORMAN DALE (Age 25) Designing Engr., Foundation Co. of Canada, Montreal, Canada.

MEDNICK, MAURICE L. (Age 25) Designer, Globe Iron Constr. Co., Norfolk, Va.

MILLER, AUSTIN JESSE (Age 25) Pres., Miller Sprinkling Systems, Detroit, Mich.

MUNOZ ALVARADO, ALFONSO (Age 30) Engr., Central Hidroelectrica del Rio Anchicaya, Cali, Colombia, in training in United States at S. Morgan Smith Co., York, Pa.

PITTA, ARTHUR LUIZ (Age 26) Asst. Reinforced Concrete Engr., Socieda de Constructora Brasileira, Ltd., Gen. Contrs., São Paulo, Brazil.

SMITH, DELBERT MARTY (Age 21) Jun. Draftsman, lighting Dept., Seattle, Wash.

WALLACE, RALPH HOWES (Age 32) Asst. Engr. with L. W. Mahone, Civ. Engr. and Land Surveyor, Clear Lake, Iowa.

WITHERS, JOHN SAMUEL (Age 27) With Wyatt C. Hedrick, Archt.-Engr., Houston, Tex.

WU, TIEN HSING (Age 25) B.S.C.E., St. John's Univ., Shanghai, China; Graduate student, Univ. of Illinois, Urbana, Ill.

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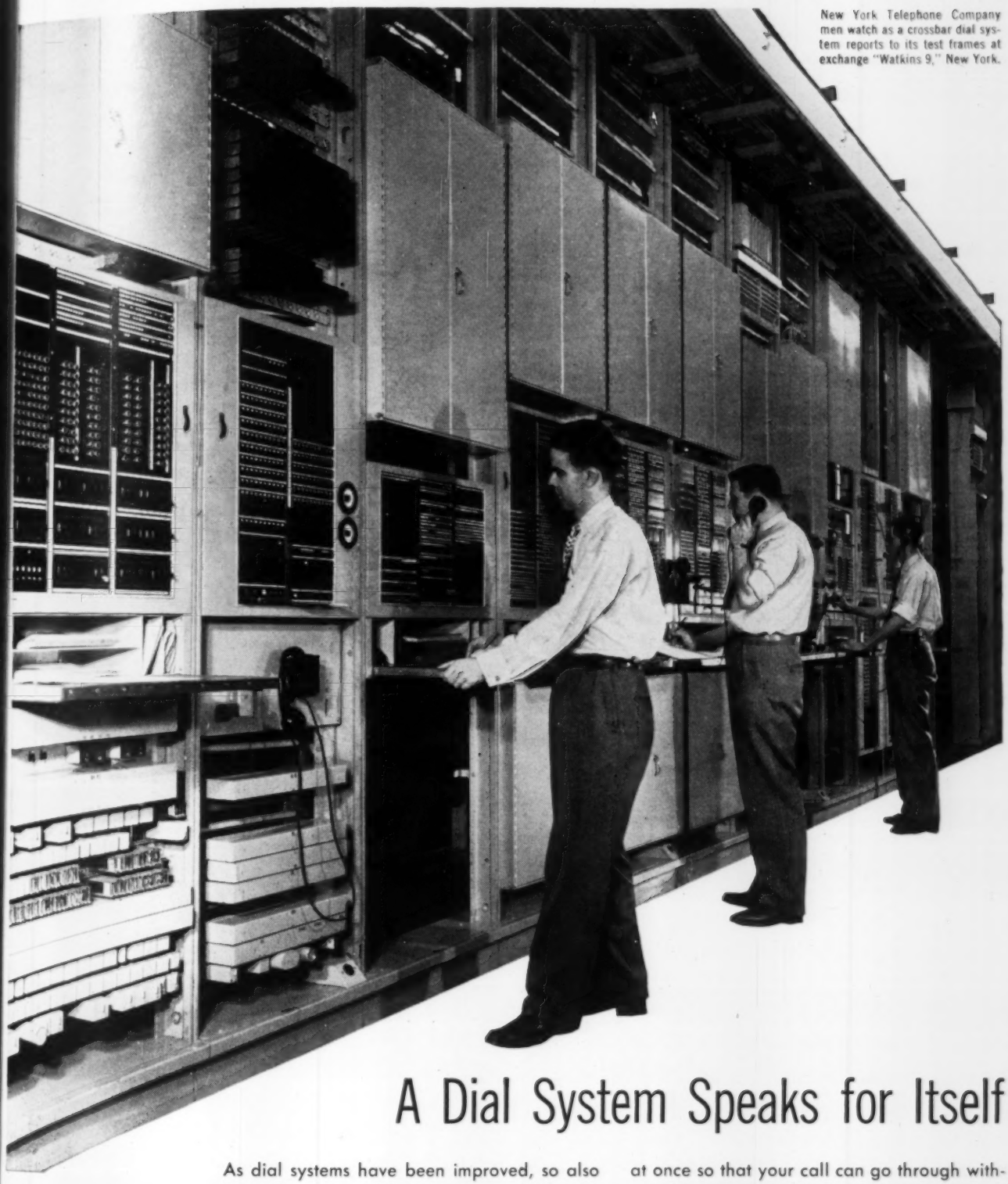


New York Telephone Company men watch as a crossbar dial system reports to its test frames at exchange "Watkins 9," New York.

A Dial System Speaks for Itself

As dial systems have been improved, so also have the means of keeping them at top efficiency. Even before trouble appears, test frames, developed in Bell Telephone Laboratories, are constantly at work sending trial calls along the telephone highways. Flashing lamps report anything that has gone wrong, and the fault is quickly located and cleared.

If trouble prevents one of the highways from completing your call, another is selected at once so that your call can go through without delay. Then on the test frames lights flash up telling which highway was defective and on what section of that highway the trouble occurred.

Whenever Bell Laboratories designs a new telephone system, plans are made for its maintenance, test equipment is designed, and key personnel trained: Thus foresight keeps your Bell telephone system in apple-pie order.

BELL TELEPHONE LABORATORIES *EXPLORING AND INVENTING, DEVISING AND PERFECTING FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE*

UNIV. OF AKRON — Age

Cockerham, Charles Edison, 1948 (23)

ALA. POL. INST.

Tackett, William Thomas, 1948 (24)

UNIV. OF ALA.

Arges, Kiro Pete, 1948 (25)
Echols, William G., Jr., 1948 (26)
Hovater, Louis Richard, 1948 (23)
Kennemer, Maclin Sloss, Jr., 1948 (28)
Killingsworth, Roy William, 1948 (23)
McInnis, James Ray, 1948 (24)
Pizarro, Juan, II, 1948 (24)
Taylor, Robert Lewis, 1948 (23)
Welch, James Shelby, Jr., 1948 (23)
Wallace, Marvin, 1948 (21)

UNIV. OF ARIZ.

Hall, Robert William, 1948 (28)
Pierson, Edward Ernest, 1948 (26)

UNIV. OF ARK.

Green, Alfred Aaron, Jr., 1948 (22)
Shivley, James Mack, 1948 (28)

BROOKLYN POL. INST.

DeCicco, Paul Richard, 1948 (24)
LoGuidice, Frank Carmine, 1948 (21)
Sadowski, Victor Felix, 1948 (24)
Tagner, Edward Charles, Jr., 1948 (22)

BROWN UNIV.

Britton, Robert Bruce, 1948 (22)
Couto, Alfred Everett, 1948 (24)
Farrell, James Henry, 1948 (21)
Nickerson, Robert Alvin, 1948 (23)
Nowell, John Turner, 1948 (24)
O'Brien, James Stephen, Jr., 1948 (24)
Pyper, Gordon Richardson, 1948 (23)

BUCKNELL UNIV.

Herman, George Jacob, 1948 (28)
Lumley, Walter Stanis, Jr., 1948 (25)
McLaughlin, Robert, 1948 (23)
Raub, Doris Mary, 1948 (21)
Reed, Robert Voneida, 1948 (26)

CARNEGIE INST. TECH.

Anderson, Richard Martin, 1948 (27)
Artuso, Joseph Frank, 1948 (20)
Brazon, Walter, 1948 (28)
Chilcote, Willis LeRoy, 1948 (28)
Corbin, Gilbert Ernest, 1948 (25)
Dickerson, William Logan, 1948 (20)
Eberle, Francis Earl, 1948 (26)
Fry, Thomas A., 1948 (26)
Hoffman, Oliver Lee, Jr., 1948 (21)
Kindl, Robert Joseph, 1947 (25)
Merz, Alvin Burtis, 1948 (24)
Reed, George Oliver Negley, II, 1948 (23)
Shope, Henry Andrew, Jr., 1948 (21)
Stein, Joseph, 1948 (20)
Stiffler, Lloyd Edward, Jr., 1948 (25)

CASE INST. TECH.

deHamel, John Belleau, Jr., 1948 (24)

UNIV. OF CINCINNATI

Krusling, James Ralph, 1948 (22)

THE CITADEL

Minges, Philip Semon, Jr., 1948 (24)
Poston, Marion Earl, 1948 (24)

CLARKSON COLL. TECH.

Avalear, John Theodore, 1948 (24)
Gabey, Martin Alexander, 1948 (24)
Hanks, Robert Eddy, 1948 (27)
Houlihan, Charles William, 1948 (28)
Murphy, William Lester, 1948 (24)
Oliver, Paul Bence, 1948 (29)
Philipp, James Joseph, 1948 (25)
Tegza, Michael, 1948 (20)
Van Deusen, James Silas, 1948 (26)

CLEMSON COLL.

Sultis, James Edward, 1948 (28)
Wallace, James Reuben, 1948 (27)

COLO. A. & M. COLL.

Burke, Thomas Frederick, 1948 (26)
Taylor, Albert Sidney Johnson, 1948 (31)

UNIV. OF COLO.

Andrews, Seward Louis, Jr., 1948 (22)
Buckland, Charles Francis, 1948 (27)
Chinn, James, 1948 (22)
Noble, Eugene Marion, 1948 (26)

COLUMBIA UNIV.

Eligator, Morton Herbert, 1948 (24)
Hedeman, Jack, 1948 (25)

UNIV. OF CONN. — Age

Scheyd, Louis Augustus, 1948 (27)

CORNELL UNIV.

Baker, Thomas James, Jr., 1948 (21)
Borsani, Alexander Henry, 1948 (23)
Burmeister, Harold Louis, Jr., 1947 (24)
Dugan, Harold Herbert, Jr., 1948 (21)
Fox, Gerard Francis, 1948 (25)
Ignaszak, Alfred Eugene, 1948 (22)
Maiorano, Albert Joseph, 1948 (23)
Ratner, Robert John, 1948 (21)
Rundell, Richard Ford, 1948 (21)
Wetzel, Vernon Francis, 1948 (26)

DARTMOUTH COLL.

Comstock, Frederick Theodore, Jr., 1948 (23)
Diemer, Arthur William, 1948 (22)
Emerson, Guy Francis, 1948 (30)
Falkin, Norman, 1948 (22)
Graves, Alfred Green, 1948 (22)
Gustenhoven, Thomas Liddell, 1948 (21)
Hanley, John Thomas, 1948 (25)
Horner, Stephen, 1948 (26)
Hughen, James Willis, 1948 (25)
Keane, Robert Edmunds, 1948 (22)
Kelly, Kendrick Arthur, 1948 (22)
Larsen, William Carl, 1948 (22)
Lightner, James Richard, 1948 (22)
Lovewell, John Sherman, 1948 (27)
Nicholl, William John, Jr., 1948 (23)
Pretat, Robert Edward, Jr., 1948 (22)
Streeter, Thomas Winthrop, Jr., 1948 (26)
Traylor, Mahlon Edward, Jr., 1948 (28)
Way, Charles Richman, 1948 (21)

UNIV. OF DETROIT

Beckley, Robert John, 1948 (26)
Cummins, Donald Kenneth, 1948 (25)
Gollon, Lucian Vincent, 1948 (27)
McDonald, Richard William, 1948 (27)
Van Antwerp, Francis Joseph, 1948 (29)
Varga, Joseph Edwin, 1948 (21)

DREXEL INST. TECH.

Abriola, Joseph Leon, 1948 (25)
Broselow, Robert Owen, 1947 (21)
Cianfrani, Anthony, 1948 (26)
Crossett, Christopher William, 1948 (25)
McClellan, Francis James, 1948 (27)
Minshall, William Thomas, 1948 (23)
O'Neill, John James, 1948 (27)
Webster, Eugene Duffield, 1948 (23)

DUKE UNIV.

Jeske, Richard John, 1948 (23)
Jones, Edwin Lee, Jr., 1948 (27)
McClees, Thomas Atwood, 1948 (25)
Rothey, Donald Calvin, 1948 (23)
Salter, Wallace Bruce, 1948 (22)
Sousa, Joseph Arthur, 1948 (23)
Spilman, Thomas William, 1948 (22)
Zitzelberger, James Allen, 1948 (23)

UNIV. OF FLA.

Green, Clifford Robert, 1948 (25)
Harra, Joseph Shirley, 1948 (21)
Meyers, Ralph Frederick, 1948 (31)
Miller, Arthur Raymond, Jr., 1948 (22)

GEORGE WASHINGTON UNIV.

Colony, David Carl, Jr., 1948 (23)

GA. SCHOOL TECH.

Moore, Warren Terrell, 1947 (22)

HARVARD UNIV.

Albert, Alfred William, 1948 (27)
Burpee, George Alexander, 1948 (25)
Curtin, Robert Harriman, 1948 (32)
Delgado, Arturo, 1948 (27)
Gizienski, Stanley Frank, 1948 (27)
Haim, Albert, 1948 (23)
Hu, Hung-Yuan, 1948 (24)
Iarrobino, Anthony Vincent, 1948 (22)
Johnson, Raymond Milton, 1948 (23)
Kaplar, Chester W., 1948 (31)
Kling, Gerald John, 1948 (25)
Kolkowitz, Hyman, 1948 (26)
Lindquist, Fred Henry, 1948 (21)
Loos, John Calvin, Jr., 1948 (24)
Meeker, Harvey Horton, Jr., 1948 (29)
Melkote, Ramachandra Rao Sitaram Rao, 1948 (26)
Murthy, Vadehalli Krishna, 1948 (27)
Muzoomdar, Natvarlal Vavabhai, 1948 (27)
Ortiz, Rolando, 1948 (24)
Patten, George Daniel, 1948 (21)
Saul, Francis Wingate, 1948 (28)
Schriever, William Robert, 1948 (27)
Seed, Harry Bolton, 1948 (26)
Young, Robert Paul, 1948 (28)

UNIV. OF IDAHO

Goff, Hollis Russell, 1948 (22)
Hofmann, Robert Julius, 1948 (24)
Jenson, Doyle S., 1948 (26)
Johnson, Philip Ellis, 1948 (23)
Olson, Elwyn Carl, 1948 (22)
Soniville, Elmer Earl, 1948 (30)

UNIV. OF ILL. — Age

Anderson, Clarence Alexander, 1948 (25)
Anderson, Hugh Robert, 1948 (26)
Andrew, Charles Arthur, 1948 (22)
Bransford, Lee Walt, 1948 (24)
Daigh, Robert Vernon, 1948 (26)
Davis, Leonard Noel, 1948 (28)
Drill, Richard Jacob, 1948 (24)
Eitel, Paul Theodore, Jr., 1948 (21)
Glitz, Arno, 1948 (24)
Hamilton, Malcolm James, 1948 (25)
McCoy, William Joseph, 1948 (22)
Nickell, Eugene Howard, 1948 (26)
Pace, Norman Allan, 1948 (25)
Petras, George Richard, 1948 (24)
Swanson, James Richard, 1948 (25)
Thelander, Jerome Atlee, 1948 (24)
Tillitt, James Cooper, 1948 (22)
Wolfe, James Edward, 1947 (27)
Wiersema, Jean, 1948 (22)
Zokaites, Francis John, 1948 (21)

IOWA STATE COLL.

Anderson, Earl Leo, 1948 (22)
Cowan, Donald, 1948 (25)
Ethington, Ivan Claire, 1948 (26)
Ferguson, Donald William, 1948 (27)
Himebaugh, Paul Harold, 1948 (21)
Larson, Dean Parker, 1948 (28)
Malcolm, Billy Carlyle, 1948 (21)
Mellerop, Kenneth Raymond, 1948 (21)
Moffitt, Robert Duncan, 1948 (27)
Pickett, Ellis Bertram, 1948 (21)
Reinhardt, William Harvey, Jr., 1948 (21)
Russell, John Davis, 1948 (22)
Schornhorst, Eldo William, Jr., 1948 (21)
Solis-Hegel, Roberto, 1948 (23)
Swan, Wayne McIntyre, 1948 (23)
Vander Hamm, Lowell Burdette, 1948 (26)
Wrenn, Van Chalmers, Jr., 1948 (26)

UNIV. OF IOWA

Bright, Kenneth Max, 1948 (26)
McCreedy, Richard Lynn, 1948 (25)

JOHNS HOPKINS UNIV.

Beard, Harry Burgess, Jr., 1948 (21)
Diver, Warren Lee, 1948 (21)
Dukehart, Russell Evan, 1948 (21)
Peeler, Joseph Greene, Jr., 1948 (23)

UNIV. OF KY.

Montfort, Donald Francis, 1948 (25)
Moore, Carlos Edward, 1948 (28)

LAFAYETTE COLL.

Anderson, William Floyd, 1948 (25)
Corbett, Harry Joseph, 1948 (23)
Dawyot, Joseph Thomas, 1948 (27)
Klitgaard, Robert Manito, 1948 (27)
Millner, Lawrence Benjamin, 1948 (24)
Noble, Edward Snow, 1948 (24)
Rodgers, Philander Knox, Jr., 1948 (26)
Shaner, Adam Fry, II, 1948 (27)
Stratton, William Coyle, 1948 (25)
Wallace, Robert Bruce, 1948 (28)

LEHIGH UNIV.

Creidenberg, Carl, 1948 (27)
Harris, George Walter, 1948 (22)
Heller, Edward France, 1948 (21)
Helthall, Stuart Robert, 1948 (24)
Hooper, James Weldon, 1948 (26)
Karpowich, Daniel Bogdan, 1948 (26)
Kuentz, Albert Chamberlin, 1948 (22)
Lamberton, Theodore Kelsey, 1948 (27)
MacDonald, Duncan Woolford, 1948 (25)
McLean, William Douglas, 1948 (24)
Mixner, Joseph Harold, 1948 (28)
Salmond, William Alfred, 1948 (24)
Schillat, Ronald Arthur, 1948 (24)
Stellfox, Samuel Kendell, 1948 (27)

LA. STATE UNIV.

Boudra, Paul Webster, 1948 (25)
Cappel, Roy Glenn, 1948 (24)
Davis, Joe Lamar, III, 1948 (25)
Forster, Joseph Landry, 1948 (20)
Kramer, John Trapp, Jr., 1948 (29)
Long, Harry Edmond, 1948 (22)
White, Hal Douglas, 1948 (25)

UNIV. OF LOUISVILLE

McGuire, John Walter, 1948 (21)

MANHATTAN COLL.

Smith, Gerard Joseph, 1948 (23)

UNIV. OF MD.

Clem, Donald Worthington, 1948 (24)

MICH. COLL. OF MIN. & TECH.

Harris, Jack Hayes, 1948 (24)
Marsh, Kenneth Ross, 1948 (25)

MICH. STATE COLL.

Enos, Donovan Edward, 1948 (24)

(Continued on page 100)

Better Water Service for Warren

A mark of a modern water system is a Horton elevated tank—one that will provide service and economy consistent with the most advanced ideas of design and construction. Horton tanks have been installed to "round out" the water supply systems of many municipalities by making possible the following advantages: uniform water pressure during peak loads; adequate reserve supply during power failure; lower pumping costs; increased capacity of water system; lower fire insurance rates.

The 500,000-gal Horton elevated tank shown above was erected for the municipal water system of Warren, Ohio. Its radial-cone bottom design is particularly adaptable to the larger capacities where a tank of conventional design would have an excessive range in head. The Warren water system supplies a population of 60,000 people, whose average daily consumption is 7,667,900 gals. The source of the water supply is the Mahoning River. Electrically-driven low-lift pumps deliver raw water to a 10 mgd filter plant at the pumping station. Filtered water is pumped into the distribution system by electrically-driven centrifugal high lift units with a capacity of 18 mgd.

Horton welded steel tanks are available with radial-cone bottoms in capacities from 500,000 to 2,000,000 gals.; with ellipsoidal bottoms, 15,000 to 500,000 gals.; and with hemispherical bottoms, 5,000 to 50,000 gals. If you're planning to install an elevated tank, write our nearest office for complete details. State capacity needed, height to bottom, and location.

CHICAGO BRIDGE & IRON COMPANY

Chicago 4 . . . . . 2199 McCormick Bldg.
Cleveland 15 . . . . . 2263 Guildhall Bldg.
New York 6 . . . . 3395—165 Broadway Bldg.
Houston 2 . . 2128 National Standard Bldg.
Havana . . . . . 402 Abreu Bldg.
Philadelphia 3, . 1652-1700 Walnut St. Bldg.
Atlanta 3 . . . . . 2167 Healey Bldg.
Detroit 26 . . . . . 1541 Lafayette Bldg.
Tulsa 3 . . . . . 1647 Hunt Bldg.
Birmingham 1 . . . . . 596 N. 50th Street
San Francisco 11 . 1284-22 Battery St. Bldg.
Los Angeles 14 . . . . . 1456 Wm. Fox Bldg.

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNA.

(*Continued from page 98*)

perience on floor plans, elevations, sections, and details of industrial, commercial, and institutional buildings. Location, South Carolina. Y-1095.

CIVIL ENGINEERS, two, graduates, under 35, with 3 to 5 years' experience in connection with building construction. Will act as owner's representatives in seeing that plans are carried out in connection with specifications. Salaries: One, $4,100, and the other, $4,900 a year. Considerable traveling. Location, New York, N.Y. Y-1101.

DESIGNING ENGINEERS, civil, with minimum of 10 years' experience in heavy construction, for work in the field with the contractor on the erection of dams, reservoirs, etc. Salary, $10,000 a year. Location, New York State. Y-1112.

ASSISTANT TO CHIEF ENGINEER in charge of design through construction of state roads, bridges, and other structures. Salary, $7,000 a year. Location, East Coast. Y-1132.

CIVIL ENGINEER with at least a B.S. degree, 26–35, to be trained to become a specialty man on surveying instruments, after which he will travel, demonstrating features of surveying instruments to all prospective purchasers, such as state highway engineers, county and city engineers, etc. Must be the salesman type. Should have some practical engineering experience, involving the use of surveying instruments. Prefer a graduate of a Mid-Western college as considerable portion of time will be spent in the Middle West. Must be willing to travel for extended periods of time. Prefer a veteran. Salary open. Headquarters, northern New Jersey. Y-1157.

ARCHITECTURAL ENGINEER with design experience. Must make perspectives and working drawings, for work on schools, etc. Rental of housing has been provided for. Salary, from $5,200–$6,000 a year. Location, North Carolina. Y-1173(*a*).

ASSOCIATE PROFESSOR in civil engineering with at least a master's degree and considerable practical experience, preferably in the field of sanitation. Salary, $4,000 for 9 months. Location, Texas. Y-1190.

TEACHING PERSONNEL. (*a*) Assistant Professor to lead research studies in hydrology, teach graduate courses and possibly assist in hydraulics. Salary, about $5,000 a year. (*b*) Professor of Structures, graduate courses, particularly experimental stress analysis and photoelasticity. May be required to fill in with undergraduate work[illegible] Doctor's degree desired, but not necessary[illegible] Salary, about $6,000 a year. (*c*) Instructors, su[illegible] veying or soil mechanics first term, and structure[illegible] second term. Salary, from $3,000–$3,300 a ye[illegible] Location, Florida. Y-1191.

CONSTRUCTION SUPERINTENDENT to represe[illegible] the architect on the job and to direct a staff of in[illegible] spectors on an 11-story, reinforced concrete ho[illegible] pital building in Pennsylvania. Salary, $6,50[illegible] $7,500 a year. Y-1209.

INSTRUCTORS OR ASSISTANT PROFESSORS [illegible] civil engineering. Prefer men with some fie[illegible] experience and with a master's degree. Sala[illegible] open. Position permanent. Location, Mich[illegible] gan. D-4242(*b*).

SALES ENGINEER, young, with college degr[illegible] and some export experience in the construction machinery field. Should have some knowledge of construction methods, preferably quarry and gravel plant layouts. Knowledge of Spanis[illegible] helpful but not required. Salary, $3,600–$4,80[illegible] a year. Headquarters location, Minneapo[illegible] R-5045-C.

(*Continued from page 96*)

	AGE
HOLGATE, JOSEPH, 1948	(22)

UNIV. OF MICH.

ABDULAHAD, ALBERT ABDULLAH, 1948	(22)
BEACH, CARTER LEROY, 1948	(22)
BEATO, ROBERTO CELIO, 1948	(27)
BURG, GEORGE REINECKE UNA, 1948	(23)
BURNS, EDWARD DEWITT, 1948	(27)
EZRA, ARTHUR ABRAHAM HYAM, 1948	(23)
FORREST, WILLIAM MELROY, 1948	(27)
GOODRICH, ROBERT MILTON, JR., 1948	(28)
HAEFELI, ROBERT JAMES, 1948	(21)
HANSON, RAYMOND LEROY, 1948	(25)
HOCKBERGER, ROBERT HUGH, 1947	(30)
JOBSE, HAROLD JAY, 1948	(25)
JOHNSON, GEORGE ARTHUR, 1948	(31)
KUS, JOHN, 1948	(27)
LASAGE, DON PALMER, 1948	(22)
MEYERS, WALTER PATRICK, 1948	(26)
NIGHTINGALE, LAWRENCE HENRY, 1948	(30)
ORMOND, DAVID MARSHALL, 1948	(27)
RACKOFF, MELVIN, 1948	(20)
REHMUS, RICHARD ADOLPH, 1948	(23)
ROSS, ROBERT MARTIN, 1948	(22)
RYDLAND, LEIV NORMAN, 1948	(22)
SNOOK, MARION KIRCHER, 1948	(21)
TRIPP, HOWARD BEARDSLEY, 1948	(26)
TUTTLE, DAVID CHARLES, 1948	(24)
VRANICH, EMIL FRANK, 1948	(24)
WHITE, ROBERT BRACKEN, 1948	(26)
WIDRIG, FRANCIS FAYETTE, 1948	(22)
YAAP, WARREN EDWARD, 1948	(25)

UNIV. OF MINN.

CHRISTOPHERSON, CHARLES DWIGHT, 1948	(21)
COLLINS, THOMAS WELLINGTON, 1948	(25)
MEYER, JOHN EDWARD, 1947	(25)
WELO, HARLAN JOHN, 1948	(23)

MISS. STATE COLL.

HEDLESTON, BOYD BRISTER, 1948	(29)

UNIV. OF MISS.

BEARD, ORVILLE SMITH, 1948	(24)

UNIV. OF MO.

BLES, THOMAS CHARLES, 1948	(28)
BLYTHE, CECIL JAMES, JR., 1948	(25)
BOBBITT, BILLIE HUGH, 1948	(22)
CROW, BROWNING, 1948	(25)
CROWLEY, EARL LYN, 1948	(26)
DEGEN, JEROME, 1948	(24)
EASTMAN, PAUL WILBERFORCE, JR., 1948	(24)
ELLIOTT, KENNETH RICHARDSON, 1948	(24)
GORDINIER, DEAN FRANCIS, 1948	(24)
GWINN, MERRITT SAM, JR., 1948	(26)
HAMMITT, ROBERT LEE, 1948	(25)
HORN, FIRMIN LEROY, 1948	(27)
JONES, HERBERT HOOVER, 1948	(22)
KIEFER, CALVIN GEORGE WILLIAM, 1948	(23)
KINCAID, HAROLD FREEMAN, 1948	(27)
MILLER, ELMER MAURICE, 1948	(25)
MOTT, THOMAS HAWKINSON, 1948	(25)
MURPHY, ARTHUR CLARON, 1948	(23)
PAPENFORT, CARSON R., 1948	(29)
PHILLIPS, LEE CHAMBERS, JR., 1948	(28)
RICHARDS, JULIAN DAVID, 1948	(25)
SCHWEFEL, HILLEL ISSIAH, 1948	(22)
SIMON, EDWARD LAWRENCE, JR., 1948	(23)

MO. SCHOOL OF MIN. & MET.

CARDIN, AUDIE VERNON, 1948	(27)
MCKINNEY, JOHN DAVID, 1948	(22)

UNIV. OF NEBR.

	AGE
GUSTAFSON, ROBERT EDWARD, 1948	(25)
MCMASTER, HOWARD MAXWELL, 1948	(27)
TALBERT, CHARLES WILLIAM, 1948	(25)
TOMEK, CHARLES ROBERT, 1948	(24)
WAGONER, DAVID ROBERT, 1948	(26)
WEAVER, LEROY WELLS, 1948	(26)

UNIV. OF NEV.

DERICCO, ELMO JOSEPH, 1948	(26)
MEFFLEY, RICHARD WEBER, 1948	(27)
WITTE, JOHN EDGAR, 1948	(26)
WOODGATE, ALFRED MELVIN, 1948	(30)

NEWARK COLL. OF ENG.

BALLIS, ROBERT JOSEPH, 1948	(21)
BRACKMANN, JOHN KARL, 1948	(22)
DERRICK, ARTHUR CALVIN, 1948	(23)
LUNETTA, ANTHONY MICHAEL, 1948	(30)
PACKET, WILLIAM, 1948	(25)
PICHE, MATTHEW WARREN THOMAS, 1948	(20)
POOL, ROBERT THOMAS, 1948	(22)
SAVRAN, MANUEL, 1948	(24)
SCHNEIDER, LEWIS, 1948	(23)
SCHUMM, WALTER RICHARD, 1948	(24)
SIERCO, JOHN DANIEL, 1948	(27)
SLOTNICK, SOLOMON, 1948	(22)
SMITH, HENRY HAZZARD, 1948	(23)
TIRGRATH, HOWARD LEWIS, 1948	(31)
WEBER, JOHN CLARK, 1948	(24)
YAMARICK, WALTER PAUL, 1948	(22)

UNIV. OF N.H.

DALE, WARREN JOSEPH, 1948	(25)
DOYLE, PAUL JEREMIAH, JR., 1948	(26)
FOGG, CHARLES EDGAR, 1948	(25)
HIGGINS, GEORGE RICHARDSON, 1948	(21)
PEASE, PHILLIP WARREN, 1948	(25)

CITY COLL. OF N.Y.

BOXER, HERMAN, 1948	(23)
CIOFFI, FRANK LOUIS, 1948	(24)
CORIGLIANO, JOHN JOSEPH, 1948	(24)
DEMBO, MICHAEL, 1948	(25)
FRANK, RITA, 1948	(21)
GAINES, ARNOLD MILTON, 1948	(20)
GASPARI, DONALD, 1948	(21)
GRAND, BERNARD ABRAHAM, 1948	(21)
ISAACSON, MORTON JULES, 1948	(20)
KAHN, DAVID, 1948	(25)
PANSKY, HARVEY DAVID, 1948	(24)
RIEGELHAUPT, RICHARD SIMON, 1948	(20)
ROSNER, MELVIN MAURICE, 1948	(22)
SPITZ, SALEM, 1948	(20)
WASSERMAN, HERBERT, 1948	(24)

N.Y. UNIV.

ANNIN, WILLIAM EDWARDS, III, 1948	(25)
BAYLES, DONALD MILLER, 1948	(24)
BRODKIN, JAMES, 1948	(24)
CHANIN, PAUL RICHARD, 1948	(21)
DEL BURGO, JOHN, 1948	(24)
EMANUEL, MANUEL SAMUEL, 1948	(20)
GIZERIAN, ROBERT, 1948	(23)
GOZ, PHILIP, 1948	(25)
HOFFMAN, JEROME JAY, 1948	(24)
MEYERSON, WARREN LEONARD, 1948	(20)
REETZ, JOHN HENRY, 1948	(28)
STELLE, WILLIAM WATTS, 1948	(30)
SEGAL, HARVEY LEE, 1948	(23)
SUAREZ, JOHN JOSEPH, 1948	(22)
SURVAL, JOHN, 1948	(24)
TEICHER, PAUL, 1948	(23)
WEAVER, LEO, 1948	(23)

N.C. STATE COLL.

BERRIER, JOE HERMAN, 1948	(23)

N.DAK. AGR. COLL.

HAUGEN, WILBUR THEODORE, 1948	[illegible]
LEVERSON, HAROLD A., 1948	[illegible]

UNIV. OF N.DAK.

ANDERSON, HARRIS ALFRED, 1948	[illegible]
COUVRETTE, ALBERT PAUL, 1948	[illegible]
ELLINGSON, ROBERT NORTH, 1948	[illegible]
GLASS, ELWYN CURTIS, JR., 1948	[illegible]
HOLLINGER, JOHN THOMAS, 1948	[illegible]
KNOLL, CLEMENT JOSEPH, 1948	[illegible]
MCLAUGHLIN, JAMES ROBERT, 1948	[illegible]
SHEPARD, DAVID SAYLES, 1948	[illegible]
THOMPSON, LYLE ELDON, 1948	[illegible]
VOGEN, CARL BLAINE, 1948	[illegible]

NORTHEASTERN UNIV.

DUNCAN, DAVID ARTHUR, 1948	[illegible]

NORWICH UNIV.

BUTTINGER, ROBERT GRAVES, 1948	[illegible]
FROST, MALCOLM GULICK, 1948	[illegible]
LAFAYETTE, FRANCIS RALPH, 1948	[illegible]
PALMER, RICHARD OSBORN, 1948	[illegible]
SHELDON, JOHN OTIS, JR., 1948	[illegible]

UNIV. OF NOTRE DAME

ARROYO, OSWALDO, 1948	[illegible]
O'DONNELL, JAMES VINCENT, 1948	[illegible]
WEIGAND, ROBERT JOSEPH, 1948	[illegible]

OHIO NORTHERN UNIV.

FRYSINGER, JACK BENARR, 1948	[illegible]

OHIO STATE UNIV.

CHURTON, PAUL MACKINTOSH, 1948	[illegible]
EDWARDS, CARL MILTON, 1948	[illegible]
GUSTAFERRO, ARMOND HENRY, 1948	[illegible]
HOLLEY, CARL ALBERT, 1947	[illegible]
LINDIMORE, DONALD THERON, 1948	[illegible]
MILLER, HOWARD FREDERICK, 1948	[illegible]
PFEIFER, ROBERT BERNARD, 1948	[illegible]
SLAVIN, SANFORD, 1947	[illegible]

OKLA. A. & M. COLL.

MCDONALD, JIMMY GLEN, 1948	[illegible]
MCKNIGHT, JOSEPH GRANT, 1948	[illegible]
RODENBERGER, CHARLES ALVARD, 1948	[illegible]

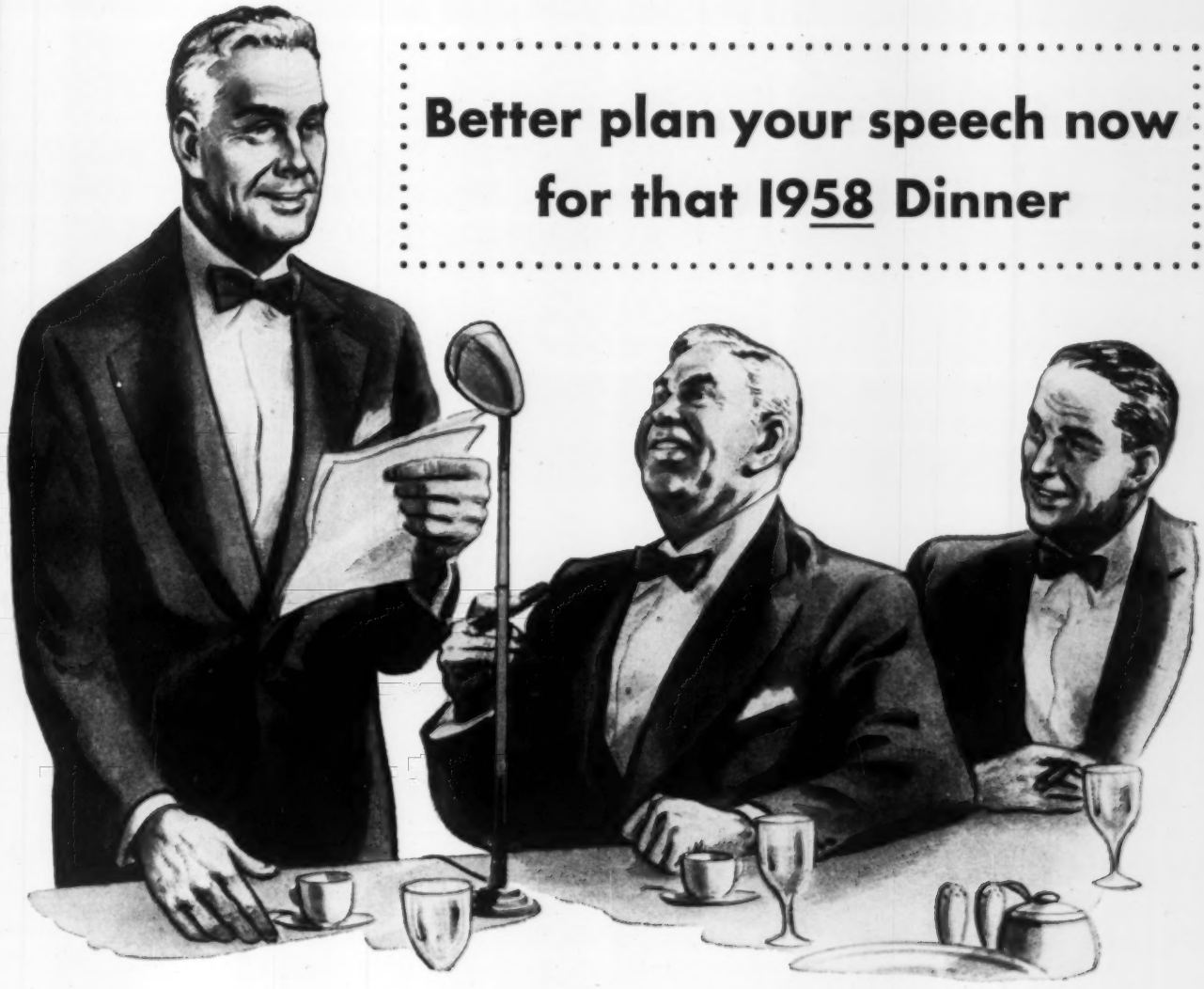
ORE. STATE COLL.

ADAMS, ROBERT RUSSEL, 1948	[illegible]
BORMAN, THOMAS MILLARD, 1948	[illegible]
CRAIG, CHARLES FREMONT, 1948	[illegible]
EBY, ROBERT EARL, 1948	[illegible]
ELLISON, ROBERT WILLIAM, 1948	[illegible]
FARR, LEO GRANT, JR., 1948	[illegible]
HODEL, LESLIE EARL, 1948	[illegible]
JONASSON, CARL VICTOR, JR., 1948	[illegible]
LANE, DELBERT EDWARD, 1948	[illegible]
MCGEE, NEIL D., 1948	[illegible]
MILES, CARTER EARL, 1948	[illegible]
MOHR, RONALD EDWARD, 1948	[illegible]
MONSON, FREDERICK HOWARD, 1948	[illegible]
NORDBY, GENE MILO, 1948	[illegible]
PAJUNEN, LLOYD ALBIN, 1948	[illegible]
PECKHAM, WILLIAM TREMAINE, 1948	[illegible]
ROBINSON, CARLTON CREW, 1948	[illegible]
SCHULTZ, IRVING, 1948	[illegible]
STEINBRUGGE, HENRY SAMUEL, 1948	[illegible]
STEINBRUGGE, JOHN MAX, 1948	[illegible]
WITTMANN, EDWARD JOSEPH, 1948	[illegible]
WOODEN, DONALD KENT, 1948	[illegible]

PA. STATE COLL.

ANNESSI, FRANK, 1948	[illegible]
BEEZUP, JOSEPH EDMUND, 1948	[illegible]
BERATAN, LEON LOUIS, 1948	[illegible]

Better plan your speech now for that 1958 Dinner



Ten years can be a mighty short span in the history of a business. *Yours* for example.

When the time comes to address your fellow executives at the "Annual Banquet" in 1958, will there be a decade of outstanding company progress for you to review?

One way to make sure of a prospering business tomorrow is to make certain *today* that your employees are buying U.S. Security Bonds regularly—on the Payroll Savings Plan. The Payroll Savings Plan is a "look-ahead" plan for both management and employees. It builds up an employee group with a sense of extra security...with a tangible stake in the nation's future...a group bound to shun dollar-destroying philosophies. At maturity, the Bonds pay $4 for every $3 invested.

P.S.P. is paying off *today*, for every Security Bond dollar built up in the Treasury retires a dollar of the national debt that is potentially inflationary. Records of the companies that actively maintain the Payroll Savings Plan show improved employee attitudes. Absenteeism and accidents have dropped as the individual's feeling of security grows with regular Bond buying.

The whole plan of action for use within your company has been mapped out. Just call your Treasury Department's State Director, Savings Bond Division.

The Treasury Department acknowledges with appreciation the publication of this message by

CIVIL ENGINEERING

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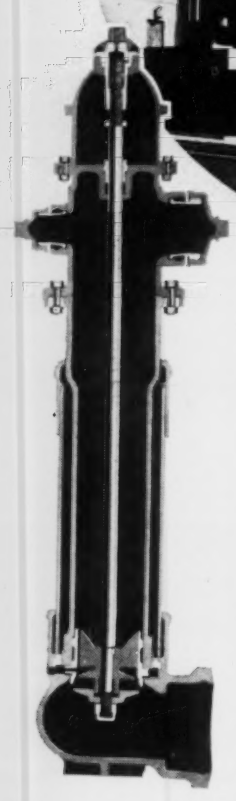


WORCESTER, MASS.

"One of America's Safest Cities"

The Mathews firemen say

THAT'S A TRUE STATEMENT. For Worcester is protected by Mathews Hydrants—and wherever there's a Mathews there's safety *plus*. Generations of service have proved the dependability of Mathews Hydrants. In these great hydrants there is virtually nothing that *could* go wrong. The stuffing-box plate, cast integral with the nozzle section, keeps water from reaching the threads and rusting them. The revolving nut is protected against rain, dust and dirt, assuring free, quick operation. The heavy stop nut prevents stripping of the stem threads. The main valve is true compression-type. Drainage is complete.

Cities and villages the world over are relying on Mathews Hydrants. Give your community this proved safety *plus*. Send for illustrated booklet.

OTHER MATHEWS FEATURES: Head can be rotated 360° • Replaceable head—nozzle outlets easily changed • Nozzle levels raised or lowered—no excavating • Protection case of Sand-Spun cast iron for extra strength, toughness, elasticity • Removable barrel—containing all working parts

MATHEWS HYDRANTS

Made by R. D. WOOD COMPANY

Public Ledger Bldg., Independence Square, Philadelphia 5, Pa.

Manufacturers of "Sand-Spun" Pipe (centrifugally cast in sand molds) and R. D. Wood Gate Valves

	Age
DAVIS, PAUL MARSH, JR., 1948	(24)
FRANCIS, IRVING CARLISLE, 1948	(23)
GOLDEN, RICHARD NEAL, 1948	(24)
JONES, PAUL HAROLD, 1948	(23)
QUIROS OREAMUNO, JUAN MANUEL, 1948	(26)
RIDER, WILLIAM LAWRENCE, 1948	(28)
RORKE, WILLIS CLAYTON, JR., 1948	(23)
WALLACE, CALVIN PHILEMON, 1948	(23)
ZELLNER, JESSE MILTON, 1948	(22)
UNIV. OF PA.	
CHOPKO, JOSEPH ALEXANDER, 1948	(24)
ROOS, JOHN TREYMANN, 1948	(26)
UNIV. OF PITTSBURGH	
BLAIR, JAMES PHILIP, 1948	(25)
PRINCETON UNIV.	
KOKATNUR, ARVIND VAMAN, 1948	(21)
PURDUE UNIV.	
ABELE, LEON MAURICE, 1948	(26)
BAZO-VILLORIA, RALPH, 1948	(27)
BOWDEN, GEORGE FRANCIS, 1948	(23)
CAMPBELL, FRANK WHITNEY, 1948	(24)
COLEMAN, RICHARD DONALD, 1948	(27)
DURNBAUGH, GORDON ALSON, 1948	(26)
ESCH, ROBERT ADAM, 1948	(23)
FINKE, ROSCOE JOHN, 1948	(25)
GIBSON, LOREN HUBERT, 1948	(25)
HAGERTY, JAMES DEWEY, 1948	(26)
HARDING, EDWARD CRITTENDEN, 1948	(21)
HARTMAN, ORVILLE LESTER, 1948	(25)
HERT, ORAL HOWARD, 1948	(28)
HOLLMEYER, LEWIS HENRY, JR., 1948	(25)
JOHNSON, CHARLES WILLIAM, 1948	(23)
JOHNSON, PAUL ARTHUR, 1948	(22)
KITTERMAN, DOUGLAS TINDALL, 1948	(24)
KOLBROOK, JOSEPH KENNETH, 1948	(25)
KRAMER, CARL THOMAS, 1948	(24)
LINDSTROM, VERNIE GLEN, 1948	(24)
LUNKENHEIMER, ELWOOD LINCOLN, 1948	(32)
MCCABE, LELAND JOSEPH, JR., 1948	(25)
MILLER, ALBERT JOSEPH, 1948	(25)
MILNE, WILLIAM, JR., 1948	(29)
PANKOW, CHARLES JOHN, JR., 1948	(24)
PHILLIPS, RICHARD EDWARD, 1948	(22)
PILCH, SOL, 1948	(22)
RAMIREZ CAJAR, RAMIRO, 1948	(26)
SCHAEFFER, PHILLIP NEGLEY, 1948	(24)
TABACHNICK, HAROLD, 1948	(20)
TODD, DAVID KEITH, 1948	(24)
WAINSCOTT, WILLIAM STANFORD, 1948	(24)
YOST, ROBERT L., 1948	(23)
ZELASKO, THEODORE EDWARD, 1948	(26)
RUTGERS UNIV.	
GERUTH, FRANCIS PHILIP, 1948	(23)
SHARPES, WILLIAM JAY, 1948	(24)
WOOLLEY, RICHARD MANNING, 1948	(23)
UNIV. OF SANTA CLARA	
CAMPI, EUGENE STEPHEN, 1948	(25)
CREEGAN, PATRICK JAMES, 1948	(24)
DUSBABEK, VIRGIL JOSEPH, 1948	(27)
HARRIS, GLENN ALBERT, 1948	(25)
JONES, ROBERT EUGENE, 1948	(24)
MCCORMICK, THOMAS EDWARD, 1948	(26)
MURPHY, RAYMOND FRANCIS, 1948	(26)
PATTEN, JOSEPH ERWIN, 1948	(26)
PEREIRA, ENRIQUE ANTONIO, 1948	(22)
VADNAIS, EDMOND JEAN, 1948	(24)
UNIV. OF S.C.	
MCCALLEY, GRAY, 1948	(23)
ROGERS, EDWARD THOMAS, 1948	(32)
THOMPSON, WILLIAM KILGORE, JR., 1948	(26)
S.DAK. SCHOOL OF MIN. AND TECH.	
AUKERMAN, FRANK CHARLES, JR., 1948	(23)
BRADY, FRANK ROBERT, 1948	(27)
DILLY, ROBERT LEE, 1948	(28)
FRANCIS, VINAL CONNER, 1948	(22)
GOODWIN, GALE ALLEN, 1948	(25)
HECK, MARVIN REINHOLDT, 1948	(24)
HIGGINS, MICHAEL AUBREY, 1948	(27)
JONES, ROBERT SHANE, 1948	(25)
LAMONT, PAUL ALBERT, 1948	(27)
LEE, JAMES THEODORE, 1948	(26)
ORVEDAHL, ROGER ARDELL, 1948	(23)
PULFREY, RONALD ROY, 1948	(28)
ROBINSON, DOUGLAS STANFORD, 1948	(24)
UDAGER, HELMAR WILLIAM, 1948	(23)
WITHEE, WARREN DUANE, 1947	(24)
WOODS, CHRIST FREDRICK, 1948	(24)
S.DAK. STATE COLL.	
AISENBREY, ANDREW JACOB, JR., 1948	(23)
STANFORD UNIV.	
BUE, OLAF ANTHONY, 1948	(28)
BURNHAM, GEORGE GLENN, 1948	(32)
CUTTING, CHARLES LEWIS, 1948	(22)
DUNLAP, LESTER BENNETT, 1948	(24)
FAIRCHILD, MERLENE GUY, 1948	(29)
FINLEY, JAMES BRUCE, 1948	(27)
GORDON, RUTH VIDA, 1948	(21)
GOSS, WILLIAM MARRETT, 1948	(27)
HATCH, ROBERT ALAN, 1948	(25)
JENKS, JOHN HARRY, 1948	(24)
KNOWLES, WILLIAM FLEMING, 1948	(23)
MILLER, RAYMOND GEORGE, 1948	(22)
PRINCE, PHILIP HUDSON, 1948	(24)
WILBOURN, SANFORD MALONE, 1948	(21)
YOUNG, CHARLES WILLIAM, 1948	(24)
SYRACUSE UNIV.	
BAUER, DAVID JOHN, 1948	(20)
RADOSH, HERBERT, 1948	(25)
SARUBBI, PANCRAZIO ANTHONY, JR., 1948	(22)
WEINER, WILLIAM GEORGE, 1948	(26)
UNIV. OF TENN.	
BUTCHER, HAROLD EDGAR, 1948	(23)
CAMPBELL, JAMES ELBERT, JR., 1948	(27)
GRAHAM, ABERNATHY, 1948	(25)
PARRIS, LEON LINDSAY, 1948	(26)
TEX. A. & M. COLL.	
COX, SIDNEY CHARLES, JR., 1948	(24)
HUMPHREY, AMOS FORDHAM, JR., 1948	(21)
PATTERSON, JAMES NATHANIEL, JR., 1948	(21)
TEX. TECH. COLL.	
BEHLING, AUGUST HENRY, JR., 1948	(26)
COLLINS, JACK BENNETT, 1948	(23)
ENLOW, BILLY JACK, 1948	(25)
HENSLEE, ST. ELMO, 1948	(23)
HICKEY, JOHN LOUIS STRONG, 1948	(21)
HILL, ANDREW BUCHANAN, 1948	(24)
LACEY, ROBERT RAY, JR., 1948	(26)
MCGOWAN, WALTER EDWARD, 1948	(25)
MCQUAIN, CHARLES EWELL, 1948	(30)
MARTIN, HORACE ALTON, 1948	(25)
NIKKEL, JOHN LESLIE, JR., 1948	(24)
REAVES, HERBERT BENNETT, 1948	(25)
SMITH, HORACE LEE, 1948	(22)
WIER, RUEBERT SAM, 1948	(25)
UNIV. OF TOLEDO	
BIEBESHEIMER, THOMAS CARL, 1948	(21)
FOX, ROBERT CLARK, 1948	(25)

	Age
U. OF UTAH	
[illegible]	(23)
Gilson, Vervin [illegible], 1948	(23)
Kemp, Clarence William, 1947	(28)
Madsen, Bud [illegible], 1948	(27)
Merrill, Robert Irvine, 1948	(23)
Monsey, Arthur [illegible]	(29)
Nilsen, Roy Edgar [illegible], 1948	(23)
Richardson, Sm[illegible]	(25)
Shaub, Donald [illegible]nes, 1948	(28)
Steele, Robert Edward, 1948	(32)
Thomas, Owen Daniel, 1948	
UTAH STATE AGR. COLL.	
Baxter, John Alden, 1948	(24)
Herbert, Henry Jarvis, 1948	(24)
Blanthorn, Chester Robert, 1948	(26)
Carter, Lee Wallace, 1948	(26)
Dunn, Irving Schenk, 1948	(24)
Hall, John Thorpe Aaron, 1948	(24)
Hampton, Boyd K., 1948	(26)
Hatch, Gerald S., 1948	(24)
Jeffries, Edward Hunter, 1948	(31)
Johnson, B. Aldus, 1948	(25)
Jones, William Rowley, 1948	(29)
Kelly, Dean Smith, 1948	(22)
Mitchell, Donald Ralph, 1948	(28)
Pack, Philip Walker, 1948	(31)
Palmer, Byron Cazier, 1948	(22)
Peirson, Paul James, 1948	(26)
Shelton, Verl Douglas, 1948	(25)
Smith, Carl Lyle, 1948	(26)
UNIV. OF VT.	
Spear, Leo Bernard, 1948	(25)
Stanley, George Clifton, Jr., 1948	(28)
VA. MIL. INST.	
Bowers, Edwin Ralph, 1948	(28)
Casey, John Roger, 1948	(21)
Casey, Joseph Hicks, 1948	(23)
Crim, David Michael, 1948	(24)
Edmonds, William Fleming, 1948	(25)
Eng, George, 1948	(28)
Fil, Joseph Frederick, 1948	(20)
Garrison, John Carl, Jr., 1948	(22)
Gemmingen, Felix von, Jr., 1948	(21)
Gianelloni, Arthur Louis, 1948	(26)
Gleason, Robert Wade, 1948	(24)
Haines, William Elvans, 1948	(24)
Hairston, Samuel McCabe, 1948	(22)
Hounett, John William, Jr., 1948	(21)
Hughes, George Farant, Jr., 1948	(25)
Jacobsen, Ted Barry, 1948	(22)
Jarrett, Edwin Allen, 1948	(23)
Kovarik, Joseph Albert, 1948	(22)
Loth, Albert Linwood, Jr., 1948	(21)
Loughborough, Stuart Dickerson, 1948	(24)
McCullough, Joseph Watkins, 1948	(24)
Moyer, Frederick Madison, 1948	(24)
Nixon, Charles Richard, 1948	(21)
Peery, Julian McCall, 1948	(24)
Pritchard, Luther Douglas, 1948	(25)
Robbins, Augustus, III, 1948	(21)
Russell, William Hamer, 1948	(25)
Scher, Isaac Meltsner, 1948	(21)
Scott, Henry Chatard, Jr., 1948	(22)
Thomas, Charles Albert, 1948	(22)
Walser, Daniel Charles, Jr., 1948	(24)
Williams, John Dickinson, 1948	(24)
Wilson, Theodore Minton, 1948	(28)
VA. POL. INST	
Cotten, Samuel Willson, 1948	(28)
Frank, Edward Thomas, 1948	(22)
Mandel, Herbert Maurice, 1948	(24)
Painter, Robert Adair, 1948	(30)
Peterson, Alexander Olaf, 1948	(30)
Rockecharlie, Benjamin Francis, 1948	(29)
Sours, John William, Jr., 1948	(23)
Thierry, Earl Mansuelle, 1948	(25)
WASHINGTON UNIV.	
Brown, John Louis, 1948	(23)
Farkas, Alois George, 1948	(30)
Gollub, Stanley, 1948	(20)
Johnson, Charles Sidney, Jr., 1948	(28)
Keyes, Robert Raymond, 1948	(22)
Lemcoe, Eli, 1948	(23)
May, Paul Henry, 1948	(25)
Mueller, Robert George, 1948	(25)
Senne, Joseph H., Jr., 1948	(28)
Shapiro, Kenneth Edward, 1948	(25)
Silverstein, Merle Lloyd, 1948	(20)
Tiarks, Fred Alan, 1948	(21)
Wilson, Edward Newton, 1948	(20)
WAYNE UNIV.	
Baune, Kenneth Joseph, 1948	(25)
W.VA. UNIV.	
Cochran, Keith Mason, 1948	(27)
UNIV. OF WIS.	
Gordon, Dale Eugene, 1948	(26)
Johnson, Owen John, 1948	(26)
Klotz, Frederick Francis, 1948	(26)
Kryshak, Edward Peter, 1948	(26)
Laffey, William Thomas, 1948	(26)

%PROPORTIONEERS%

HEAVY DUTY CHEM-O-FEEDER

Even if the watched kettle never boils you can have safe, pure water with %Proportioneers% Heavy Duty Chem-O-Feeder. This inexpensive, dependable chemical feeder will automatically purify up to a million gallons of water a day. Cross-connected to the starting switch of the main pump motor, the Chem-O-Feeder operates exactly in step with the pump and sterilizes every drop of water. It feeds just the right amount of hypochlorite or other chemical — eliminates the unpleasant taste resulting from overfeeding, and prevents dangerous undertreatment. Write for Bulletin SAN-2.

ADJUSTMENT WHILE IN MOTION. By simply turning a knob which varies the stroking length, the amount of chemical fed can be precisely adjusted while the pump is operating.
CONTINUOUS FEEDING. Unique stroking arrangement gives long feeding stroke and short suction stroke — provides uniform distribution.
"SEE-THRU" PLASTIC REAGENT HEAD. Safely handles all water treating chemicals — shows the movement of the parts and the flow of liquid being fed.
PROVEN DESIGN. Over 24,000 "%Proportioneers"% units are in use all over the world.

% PROPORTIONEERS, INC. %

14 Codding Street, Providence 1, R. I.

	Age
Rizzi, Arthur Francis, 1948	(26)
Vosswinkel, Gilbert, 1948	(22)
WORCESTER POL. INST.	
Cromack, Roger Marvin, 1948	(20)
Kulin, Gershon, 1948	(22)
Lentell, Lynwood Wilmarth, 1948	(23)
Lunchick, Myron Edwin, 1948	(22)
Meadowcroft, William Entwistle, 1948	(23)
Morse, Charles Arthur, Jr., 1948	(24)
Mullarkey, James Michael, 1948	(22)
Nagler, Bruce Edwin, 1948	(22)
Raymond, Allan Everett, 1948	(24)
Riedel, Alan King, 1948	(24)
Stevens, Prescott Allen, 1948	(26)
UNIV. OF WYO.	
Burgener, Clem R., 1948	(30)
Covington, Dwight Archie, 1948	(21)
DeBernardi, Alfred Valentino, 1948	(24)
Larsen, Robert Louis, 1948	(30)
Logan, Jac, 1948	(24)
McBeath, Bernard Charles, 1948	(25)
McCall, Warren Burton, 1948	(30)
Rechard, Paul Albert, 1948	(21)
Seifried, Robert Dayton, 1948	(24)
Stiles, William Homer, 1948	(28)
Vaudrey, Calvin, 1948	(24)
YALE UNIV.	
Crowley, George Tynan, 1948	(23)
Koch, Edward Forrest, 1948	(27)
Levine, George, 1948	(22)
Lewis, Robert Milton, 1948	(24)
Swift, John Longworth, 1948	(26)

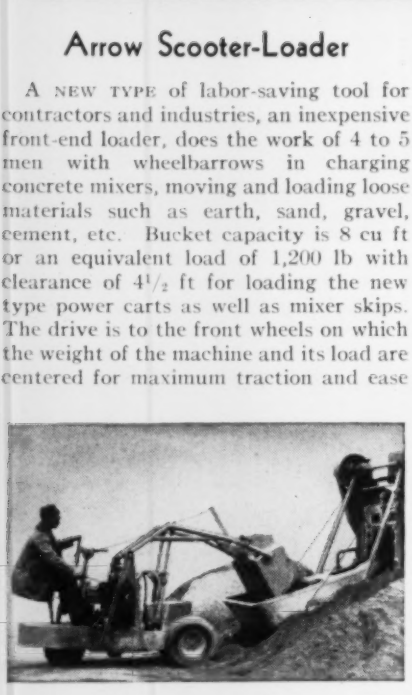
The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

EQUIPMENT, MATERIALS *and Methods*

NEW DEVELOPMENTS OF INTEREST, AS REPORTED BY MANUFACTURERS

Arrow Scooter-Loader

A NEW TYPE of labor-saving tool for contractors and industries, an inexpensive front-end loader, does the work of 4 to 5 men with wheelbarrows in charging concrete mixers, moving and loading loose materials such as earth, sand, gravel, cement, etc. Bucket capacity is 8 cu ft or an equivalent load of 1,200 lb with clearance of 4½ ft for loading the new type power carts as well as mixer skips. The drive is to the front wheels on which the weight of the machine and its load are centered for maximum traction and ease



Scooter-Loader

of control. Castor-type rear wheel enables the Scooter-Loader to turn in its own length, a great advantage. Its transmission provides 4 forward speeds for a complete range of power and travel up to 15 mph, plus one reverse speed which is needed only for backing before turns. Traction-grip pneumatic tires provide ample traction on soft or sandy ground. The machine is powered with 9-hp, air-cooled engine. As a loader compact enough to work inside freight cars as well as factories and yards, the machine is equally useful for foundries, fertilizer and other chemical plants and similar industrial applications. The price of the Scooter-Loader is approximately one half that of larger capacity front end loaders. **Arrow Contractors Equipment Co., 2020 Walnut St., Chicago, Ill.**

Portable Gasoline Rammer

FOR SOIL COMPACTION in places where rollers cannot reach, a portable rammer has been developed. The rammer requires no manual labor by the operator except a slight push down on the handles which causes the rammer to jump upwards under the operator's control and drop by its own weight. The machine is easily moved in any direction by tipping it slightly. The simplicity of design and unusually sturdy construction, plus the fact that a smaller amount and lighter grade of oil is required, give this new Barco rammer a practically negligible maintenance cost. **Barco Mfg. Co., Chicago, Ill.**

High Pressure Rotovalves

TWO OF THE HIGHEST PRESSURE Rotovalves ever built for service as main stop valves at the lower ends of penstocks adjacent to hydraulic turbines were recently completed by the S. Morgan Smith Co. These Rotovalves are to be installed at the new Electra Plant of the Pacific Gas and Electric Co. on the Mokelumne River in California. They are each 36 in. in diameter and will operate under a head of almost 1,300 ft. It is believed they will be the first valves of this type used for hydro-electric service on the Pacific Coast of the United States. **S. Morgan Smith Co., York, Pa.**

Portable Welder

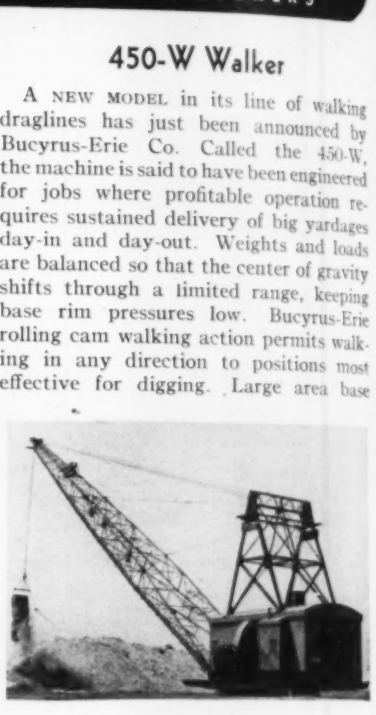
A NEW PORTABLE WELDER of the gasoline engine-driven type, especially designed to bring to the welding industry an inexpensive complete, light weight model is announced by The Lincoln Electric Co. Of particular value for welding applications in areas where electric power is not readily available such as garages, job shops, repair shops, oil and gas fields and construction work, this 180 amp welder known as the "Lincwelder," is of compact design, roughly 2 ft wide, 2 ft high, 4 ft long and weighing much less

Lincwelder

than the usual equipment of this type and size. With a current range of from 20 to 180 amp, the machine can be used for the welding of light or heavy gauge metal, for the repair of cast iron structures, etc. Unique features include the following: Provision is made on the output panel for three ranges of output current; generator controls are mounted inside an enclosed cabinet above the generator; the welder is powered by a Wisconsin air-cooled, 2-cylinder engine; and mounting rails for bolting to floor or platform permit the welder to be mounted on either shop trailer or high-speed, road-type, two-wheel trailer. **Lincoln Electric Co., Cleveland, Ohio.**

450-W Walker

A NEW MODEL in its line of walking draglines has just been announced by Bucyrus-Erie Co. Called the 450-W, the machine is said to have been engineered for jobs where profitable operation requires sustained delivery of big yardages day-in and day-out. Weights and loads are balanced so that the center of gravity shifts through a limited range, keeping base rim pressures low. Bucyrus-Erie rolling cam walking action permits walking in any direction to positions most effective for digging. Large area base



450-W Walker

and shoes, coupled with proper weight distribution, make possible walking and working on soft ground in all kinds of weather. The 450-W swings 8- to 10-cu yd buckets from 200 to 165 ft booms. With an 8-yd bucket and 200-ft boom, it can move material 407 ft without throwing the bucket. A heavy-duty, diesel engine provides proper power characteristics for high-speed digging and quick, easy moving. Hoisting and lowering are through air-operated clutches and brakes. Swing machinery is under Ward-Leonard variable-voltage control. Simple and sturdy, the machinery is held in rigid, accurate alignment and is easy to get at for servicing. Light, welded boom, of T-section chord members with tubular bracing, gives maximum strength with minimum dead weight. **Bucyrus-Erie Co., S. Milwaukee, Wis.**

Large Capacity Pulverizer

CAPABLE OF PRODUCING 170 TONS of ag-lime per hour, or more, a new, large capacity pulverizer is said to be limited only by the speed with which the operator can feed stone and by the facilities available for storing or hauling away the finished product. The size of this machine is 32 in. by 38 in. and requires 320 hp to produce the capacities mentioned. The feed opening is 22 in. by 50 in. permitting the passage of large rocks for primary crushing purposes. The owner plans to use this portable machine for producing road aggregate and doing primary rock crushing in addition to making ag-lime. **Lippmann Engineering Works, Milwaukee, Wis.**

Nylon-Coated Cable

WIRELON, a nylon-coated wire rope now being commercially produced is said to open up extensive new product possibilities as well as to lengthen the life of steel cables where wire rope is already used. Although chemically similar to the nylon used in women's hose, the coating on Wirelon is not woven or filamented but solid and very tough. It is unharmed by alkalies and by such acids as nitric, hydrochloric or sulphuric in concentrations up to approximately 1 percent. Temperature tests show that Wirelon ropes operate well at high and low temperatures, and that they retain flexibility whether wet or dry. The coating is being used by Rochester in the manufacture of three distinct types of rope. In the first, nylon is extruded onto single strands of wire which can then be used in many services where more expensive, fully formed ropes were heretofore required. The second type is more flexible and is made by applying the plastic to the outside of wire ropes that are already completely formed. Still more flexible then either of the other types is nylon-wire rope made by the third method in which individual strands are coated with nylon, and the coated strands then closed into a finished rope. Wirelon will be available in diameters ranging from $1/32$ in. to 1 in. or greater. **Rochester Ropes, Inc., Culpeper, Va.**

Scrapers

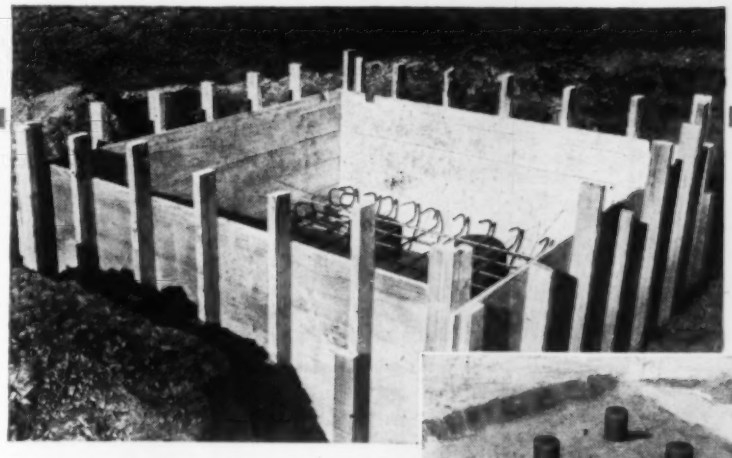
THE LINE OF SCRAPERS offered by Jumbo Steel Products includes rotary wheel, leveler and drag scrapers. The rotary wheel-scrapers feature maximum load capacity with minimum power required. Equipped with dust-proof Timken roller bearings, they are adaptable for tractors with 15 to 75 hp. Mechanical operating levers are provided which are controlled directly from the tractor operator's position. As this type of scraper is semi-carrying, more dirt is said to be moved with less horsepower, and larger tractors can operate in higher gear. The leveler-scrapers are dual purpose implements with two-position wheels. When the wheels are attached in the rear position, the implement performs as a leveler and when the wheels are changed to forward position, it performs as a scraper without need for an additional piece of equipment. Three adjustable cross shaft arms provide adjustment for a level cut and spread at all times. Marketed under the trade name of Movmor, the 5- and 6-ft drag-scrapers have been built for rough usage. They have a balance-type bowl which scoops up the dirt, automatically tilts back into carry position when loaded, carries the load and dumps while the tractor is still in motion. **Jumbo Steel Products Co., Azusa, Calif.**

PERMANENT AND ECONOMICAL

from the bottom up, with

KOPPERS PRESSURE-CREOSOTED

PILES



Koppers Pressure-Creosoted Piles in an Ammonia Storage Tank foundation

Wherever a foundation job calls for piling—*it's good business to call for Koppers Pressure-Creosoted Piles!*

Pressure-creosoted piles—tops soaked in creosote and capped in concrete—are included in modern building codes for permanent foundations. Penetration of creosote protects the wood against decay and termites. The surrounding earth smothers evaporation of the creosote.

Creosoted piles, pulled after nearly 50 years use, were "reeking with creosote."

Theoretical estimates of the life expectancy of creosoted piles run into many hundreds of years.

Koppers Pressure-Creosoted Piles have an earned reputation for economy and permanence.

Of equal importance—Koppers Treating Plants have an earned reputation for keeping delivery promises.

KOPPERS

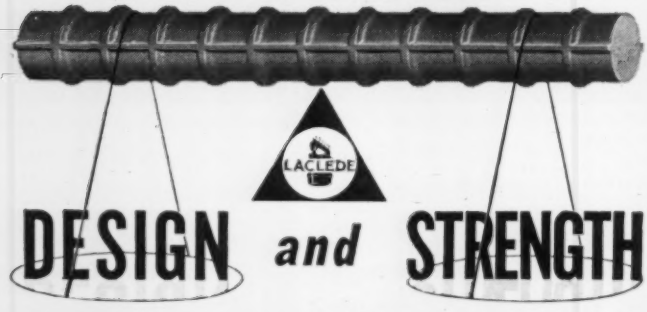
PRESSURE-TREATED WOOD

KOPPERS COMPANY, INC.

PITTSBURGH 19, PA.

The first of a Series in the interest of more efficient use of steel, a vital American resource

BALANCED



DESIGN *and* STRENGTH

MULTI-RIBBED for MAXIMUM ANCHORAGE . . .
HIGH STRENGTH for STEEL—CONCRETE SAVINGS

"30 years ahead of the building codes"—that's the verdict on the Laclede Multi-Ribbed Reinforcing Bar. All tests show that the long sought balance between high strength and adequate anchorage has been achieved. The combined factors of high yield point (in excess of 55,000 PSI) plus improved deformations give greater reinforcement strength and provide a more efficient use of steel . . . conserving America's most important resource while effecting material savings on the job. Laclede bars meet ASTM Specifications A305-47T, for improved reinforcing bars, developed in the interest of modern, efficient use of steel.

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LACLEDE
Producers of Construction Steel

LACLEDE STEEL COMPANY
St. Louis, Mo.

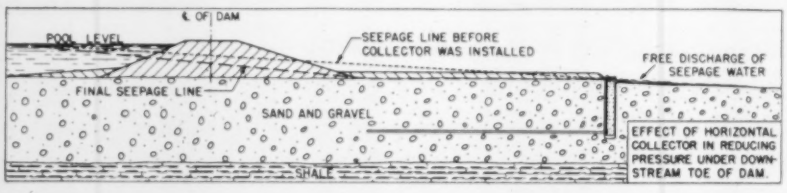
WATER SUPPLY DESIGN PROBLEMS

Prevention of Dangerous Underseepage at Dams

Many earth and concrete dams are being built on pervious foundations. A major problem in the design of such structures is the prevention of dangerous underseepage or uplift pressures which may threaten the stability of the structure.

HORIZONTAL COLLECTORS may be used to good advantage in connection with such structures

1. To dewater the construction area while work is in progress.
2. To provide permanent underdrainage and pressure relief after the dam has been completed and the reservoir filled.


℄ OF DAM
POOL LEVEL
SEEPAGE LINE BEFORE COLLECTOR WAS INSTALLED
FREE DISCHARGE OF SEEPAGE WATER
FINAL SEEPAGE LINE
SAND AND GRAVEL
EFFECT OF HORIZONTAL COLLECTOR IN REDUCING PRESSURE UNDER DOWNSTREAM TOE OF DAM
SHALE

RANNEY METHOD WATER SUPPLIES, INC.
RANNEY WATER COLLECTOR CORP. of N. Y.
Water Supply Engineers and Contractors
EXECUTIVE & ENGINEERING OFFICES: COLUMBUS, OHIO

Electric Arc Stud Welding

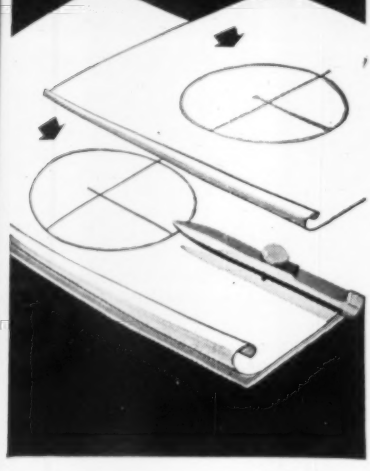
A NEW METHOD of applying corrugated sheet metal and protected metal to roofs has been developed featuring an electric arc stud welding gun and special rivet-studs. With this new method, the necessity of scaffolding and rigging is eliminated. A stud welding gun is employed to end-weld rivet studs to the steel purlins. More than a 50 percent reduction in the direct application cost of applying corrugated sheet metal to roofs is reported by this novel method of fastening. The operation of the welding gun is simple. The welding time interval is regulated by a timer control box which is part of the equipment. This timer control is set only once for the ordinary job. To make the weld, an operator inserts a flux-filled stud into the chuck of the gun and adjusts a porcelain ferrule in the proper position around this stud. He next places the stud firmly against the steel purlin through a special lightweight template and presses the trigger button on the gun to end-weld the stud into position in less than one second. The welding gun operates from the usual type of welding generator of a rated size suitable for welding the size of the stud required for the job. After the stud welder shoots the rivet studs into position on the steel purlins through the template, the corrugated metal sheets are laid in position on top of the rivet studs. A sheeter then uses a rubber hammer to impale the sheet metal over the piercing extensions of the rivet studs. Side laps are secured with the ordinary sheet metal screws. **Nelson Stud Welding, Div. of Morton Gregory Corp., Lorain, Ohio.**

The Stud Welding Gun

Portable Screening and Loading Plant

FOR USE IN AGGREGATE PRODUCING OPERATIONS in which a crusher is not needed, a portable screening and loading plant has been developed. The plant consists of a Cedarapids heavy-duty, double-deck horizontal vibrating screen, 3 folding type channel frame conveyors and an apron feeder with charging hopper and grizzly, all mounted on a pneumatic tired transport truck. Completely portable, it is adaptable to most any screening and loading setup and will produce the required finished sizes of aggregate on a job. **Iowa Mfg. Co., Cedar Rapids, Iowa.**

Tracing cloth that defies time



• The renown of Imperial as the finest in Tracing Cloth goes back well over half a century. Draftsmen all over the world prefer it for the uniformity of its high transparency and ink-taking surface and the superb quality of its cloth foundation.

Imperial takes erasures readily, without damage. It gives sharp contrasting prints of even the finest lines. Drawings made on Imperial over fifty years ago are still as good as ever, neither brittle nor opaque.

If you like a duller surface, for clear, hard pencil lines, try Imperial Pencil Tracing Cloth. It is good for ink as well.

IMPERIAL TRACING CLOTH

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Improved Paving Breaker

A REVOLUTIONARY PAVING BREAKER, designed to do the work of five ordinary 85-lb, hand-held machines with only one 105-cfm compressor, is being introduced by the R.P.B. Corp. Named the "Mighty Midget," the new machine is designed to round out a line of paving breaker equipment produced by the Corporation. It will break concrete and other high types of pavement up to 10 in. thick and will tamp backfill. One of the most unusual

The Mighty Midget

features of the improved Midget model is its ability to operate at its rated capacity of 55 to 60 blows per min on a 105 cu ft per min air compressor. The machine, which can be operated by one man, is mounted on a tricycle running gear and is driven by an air motor having ability to move it up a 15-deg incline. The air motor is geared to its wheels, and an operator's seat eliminates operator fatigue. Small in size, the machine is sturdily built throughout. Seven types of standard Junior paving breaker tools will also fit the Mighty Midget, and special tools for special applications will be furnished upon request. It is expected that the new machine will lower concrete demolition costs of small jobs appreciably. It performed 5 times faster than hand-held paving breakers on 4-in. thick concrete laid on top of a brick pavement. **R.P.B. Corp., 2751 E. 11th St., Los Angeles, Calif.**

Metal Tree Well

SIMPLE AND LOW COST PROTECTION for standing trees in fill areas is claimed for a new line of galvanized corrugated metal tree wells. Made of 16, 14 or heavier gauge galvanized corrugated steel in two matching semi-circles, installation is a simple matter of placing in position around the tree and bolting together. A rolled top edge is said to give extra rigidity thus permitting fills to within an inch of the well height. The wells are fabricated to a 24 in. height as standard but are produced to any height on specification. A special tree well is also produced for hillside fills. **United Steel Fabricators, Inc., Wooster, Ohio.**

Serving Our Biggest *STEEL MILLS*

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But as with Steel Mills, Layne Well Water Systems are also serving other great industries; chemical plants, oil refineries, paper mills, packing houses, factories and big and little cities by the hundreds.

It is a well known fact that Layne Well Water Systems are built to the very highest standards. They are installed exclusively by the Layne Organization Affiliated Companies—and according to Layne's exacting specifications.

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More than 50 years of leadership and experience in developing special purpose cloths for industry. With such a background of experience it is little wonder that Holliston Tracing Cloth is second to none. Try MICRO-WEAVE.

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Send for catalogs descriptive of the latest foundation types and methods.

SPENCER, WHITE & PRENTIS, INC.
10 EAST 40th ST. NEW YORK 16, N.Y.

Non-clog Sewage Pump

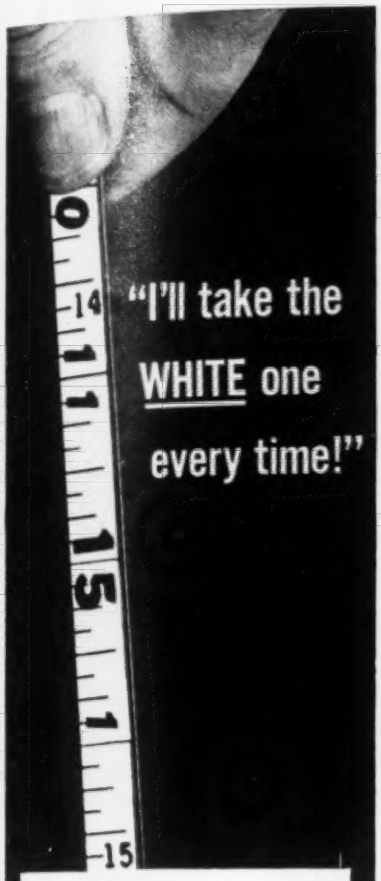
A COMPLETELY REDESIGNED and improved small, non-clog, sewage pump is announced by Economy Pumps, Inc. The new pump is primarily adapted to the pumping of miscellaneous pulps, sewage or trash. Shaft and bearings have been increased in size, using a two-row, heavy-duty ball bearing with matched angular contact thrust bearings. Both radial and thrust bearings are enclosed in a subassembly cartridge for easy, quick replacement of the rotating element. Removal of the rotor does not expose bearings to dirt and does not lose adjustment of bearings. For protection against moisture and corrosive gas, all bearings are grease lubricated. Six rings of packing with a lantern for external seal connection are provided on the stuffing box. The sturdy labyrinth flinger is positive with a large bearing surface to eliminate any leakage between the shaft and flinger. A simple external adjustment is provided to take up wear at the impeller inlet. **Economy Pumps, Inc., Hamilton, Ohio.**

Double Impeller Breaker

DESIGNED TO PRODUCE cubicle crushed aggregate, the new 2020 double impeller breaker recently announced by the New Holland Mfg. Co. has a capacity of 50 to 135 tons per hour, operating on 50 to 100 hp. The machine is built on the same engineering principles as the 3030 breaker. Impact applied in suspension is used to reduce any stone passing through a 20-in. opening. While this breaker is designed primarily for gravel work, it has the same rugged construction as the 3030 and may be used to reduce material not exceeding 20 in. by 20 in. by 36 in. Weight is 20,000 lb. Like the 3030, the 2020 has no vibration. Two impellers are carefully balanced. Because of their weight, these impellers, spinning in opposite directions, act somewhat like a gyroscope in keeping the machine stable in operation. **New Holland Mfg. Co., Mountville, Pa.**

Power-Driven Staging

SPIDER STAGING, a light weight power-driven staging unit, said to make ordinary rigging methods for high work jobs obsolete, is now in successful use. It is reported to effect unusually large savings in the man-hours required in many types of off-the-ground work. The stage itself is constructed of aluminum alloy with a double guard rail completely surrounding the operator. All driving parts are of alloy steel. In use, the stage is suspended on an extra flexible wire rope which winds on a power-driven drum beneath the platform of the unit. Power unit consists of a totally enclosed 172 to 1 reduction gear driven by a standard $\frac{1}{3}$-hp capacitor-



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STEEL MEASURING TAPES

The man who knows and uses measuring tapes instantly recognizes the superiority of WYTEFACE "A" Steel Tapes. Raised black graduations and rims, on a crack-proof white surface, make these steel tapes as easy to read in the brightest glare as in the dimmest light. See WYTEFACE "A" heavy duty and general purpose steel tapes at your dealer's, or write for catalogue.

WYTEFACE Steel Tapes and Tape Rules are protected by U. S. Patent 2,089,209.

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EST. 1867
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SAN FRANCISCO • LOS ANGELES • MONTREAL

type electric motor. Operator controls the stage by means of a standard Cutler-Hammer three-button reversing switch and can ascend or descend vertical drops of up to 650 ft at an average speed of 18 ft per min. Two Spider Stagings can be joined with a connecting platform to make a power-driven swing stage. By means of a special transfer chain with which Spider Staging is equipped, the operator can move it horizontally without returning to the ground. Safety features include three independent automatic braking systems, any one of which will prevent the stage from falling. In addition, there is an automatic overload switch which cuts off the power in the event of an overload. The worm gear propulsion unit enables the staging to lift a half ton load. **Spider Staging, Inc., Renton, Wash.**

Palletless Materials Handling

VERSATILE ADVANCEMENT in palletless materials handling is said to be accomplished by the Hyster Load-Grab which is available for use with the Models 20 and 40 lift trucks. Designed for a handling capacity of 1,780 lb on the Model 20 and 3,350 lb on the Model 40, the Load-Grab arms will squeeze-grip bales of cotton, rags or wool, cartons or boxes, drums or barrels with equal facility. The steel arms are operated and hydraulically controlled from a lever at the driver's right. They spread from a minimum 17 in. to a maximum 62 in. on the 20 and 66 in. on the 40, and can be lowered to within 6 in. of the floor. An adapter plate will permit lowering standard Load-Grab arms or standard lift forks to ground level. Optional sets of equipment, for special application of the device, include spiked faced arms for clutching wooden boxes and crates; rubber faced arms for particularly gentle handling; drum handling load arms for transporting from 1 to 3 drums per trip; and conventional pallet load arms. **Hyster Co., Portland, Ore.**

New Concrete Form

A METAL FORM, recently made available, is said to cut the cost of erecting and stripping concrete forms. Chief feature of the new form is a patented wall-tie which is secured to the forms with ordinary 16-penny, square-cut nails. This unusual wall-tie not only spaces and holds the opposing panels, but also attaches adjacent panels of the form. The ties can, if necessary, be made on the job from No. 6 wire using the patented Bulldog tool which crimps the wire ends to form a tie identical with the Bulldog factory-supplied ties. Wood, carpentry and finishing, major time and cost factors in forming concrete by other methods, are virtually eliminated with the new form. Steel aligners, used only on outside walls, replace walers and strongbacks. Carpentry is avoided by using panels in 7 different widths and heights from 4

M&H

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Pipe Line Accessories for Water Works and Sewage Works

Write for Catalog No. 34

VALVES: A.W.W.A. type iron body, bronze mounted with double-disc parallel seat or solid wedge type. Non-rising stem, outside screw and yoke, or with sliding stem and lever. Also furnished hydraulically operated. Square bottom type operates in any position.

HYDRANTS: Standard A.W.W.A. type approved by Underwriters and Factory Mutuals.

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SHEAR GATES
MUD VALVES
VALVE BOXES
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MORE EFFICIENT
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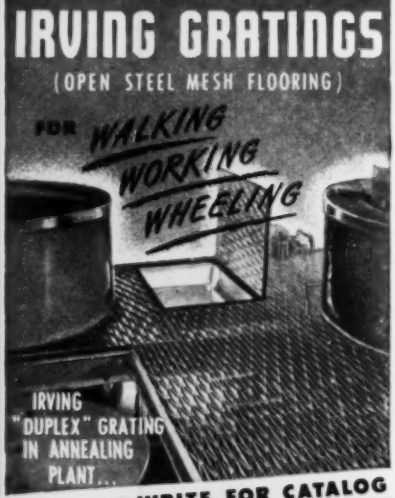
(OPEN STEEL MESH FLOORING)
FOR WALKING WORKING WHEELING



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ESTABLISHED 1902
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LONG ISLAND CITY 1, NEW YORK
Western Division: Foot of Park Ave.
EMERYVILLE 8, CALIFORNIA

to 10 ft. By setting up panels horizontally, vertically and both ways, any dimension to within 1 in. can be formed. Once set in place, the panels give even, tight, flush joints which make finishing unnecessary on most jobs. The panels, light enough for one-man handling, are made of high-tensile, corrosion-resistant steel and will withstand 65 to 80,000 psi. Any panel is removable to place concrete at a lower level or for replacement by a special plywood-faced panel to which boxes, frames, and sleeves can be attached. Informational folders can be obtained from the Company. **Bulldog Concrete Forms, Inc., New York 18, N.Y.**

Literature Available

CENTRIFUGAL AND ROTARY UNITS—A 4-page folder in two-colors, designated as bulletin G-82, illustrates and briefly describes the entire line of products manufactured by Roots-Connersville Blower Corp. The front cover mentions the firm's position as the only builders of both centrifugal and rotary units for which they have coined a word, "dual-ability." The center spread shows illustrations of the complete line of products. Brief text matter accompanies the cuts. On the back cover appears a general listing of the various uses for which the equipment is suited, the applications being covered as to usage rather than industries. **Roots-Connersville Blower Corp., Connersville, Ind.**

STANDARDIZED GRANITE CURB—Complete specifications applicable to a variety of types of curbs or edgings are set forth in an illustrated 10-page bulletin. Ten advantages to be gained by using Chelmsford white granite curb are also discussed and a chart gives ordinates for a given chord and radius figured to the nearest 1/8 in. **H. E. Fletcher Co., Inc., W. Chelmsford, Mass.**

TOURNADOZER FOLDER—Application photos and diagrams, featured in a 4-page folder, help explain how non-productive dozer time can be cut and how dozer work can be generally speeded up with a Tournadozer. All the new features designed and built into the Tournadozer are explained. Basic specifications for this 180-hp, 15-mph tool are given on the back cover. **R. G. Letourneau, Inc., Peoria, Ill.**

PRECISION INSTRUMENT BROCHURE—An informative, 4-page brochure, combining a catalog and calculating chart, has been prepared by C. L. Berger & Sons, Inc. Pictured in 4 colors on the cover is the Type R transit, one of many instruments produced by the firm. On the center spread are photographs and code names for 12 types of instruments, from an 18-in. Dumpy level to a plane table alidade. On the back of the brochure is a useful chart which gives, at a glance, the lengths of circular arcs. **C. L. Berger & Sons, Inc., Boston, Mass.**

TIDE GATES

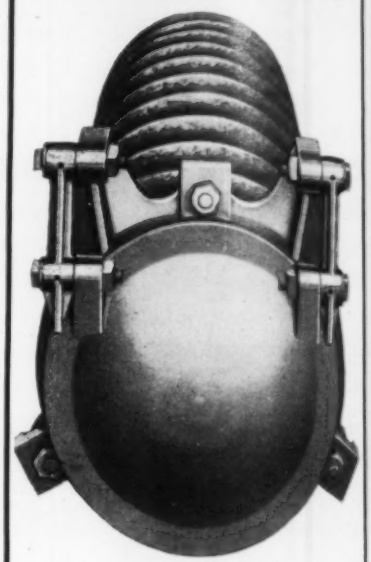

FIG. B-147

Type M-5 Tide Gates for use with Corrugated Culvert Pipe. Bulletin No. 91 describes them fully.

BROWN & BROWN, INC.
LIMA, OHIO, U. S. A.

PARTNERS WANTED

A number of large dams of different kinds are going to be constructed in various parts of India in the near future. These dams for speedy completion require trained engineers and mechanical equipment which at the moment are lacking in this country and shall have to be imported from abroad. Representatives of various construction companies in U. S. A., U. K., France, Switzerland and other countries in the world are anxious to undertake these works, but their chief handicap lies in total absence of knowledge of local conditions and contacts. Our firm which has large financial backing and considerable influence in the country and has several industrial undertakings is prepared to enter into partnership with such firm as may like to undertake construction of large dams in India. Correspondence may be made in confidence with **Seth M. F. Jaipuria, Swadeshi House, Civil Lines, Kanpur (U. P.) India.**

Literature Available (Cont.)

POWER HOE—A modern, frameless, one-bag, plaster-mortar mixer is described in a 4-color, illustrated folder. Known as a Power Hoe, the machine is lower, more compact and lighter than old style mixers. In addition to specifications, the bulletin shows how the machine produces a strong, even-tempered mix, makes discharging easy by means of a lever-controlled, quick-acting gate, and saves materials and the finished product. **Jaeger Machine Co., Columbus, Ohio.**

GALVANIC CORROSION—A new booklet discussing various aspects of galvanic corrosion has been issued. Prepared under the supervision of the Company's corrosion engineering section, it is designed for the production man as well as the research engineer. The booklet not only covers some of the factors influencing galvanic corrosion but also presents data on how galvanic effects can be minimized. **International Nickel Co., New York, N.Y.**

PRECISION ALTIMETER—A new, low-range surveying altimeter, determining elevations accurately in about one-tenth of the time required by vertical angle or spirit leveling, is described in a 4-page folder. How this instrument brings a new order of accuracy and adaptability to precision altimetry is briefly but clearly explained in the folder in addition to sections giving information on design, construction, operation, advantages and uses of the altimeter. **Wallace & Tiernan Products, Belleville, N.J.**

E-Z-V-C TABLES—A new publication, designed to aid civil engineers, draftsmen and construction men in the rapid calculation of vertical curve corrections, has recently been released. The E-Z-V-C Tables, written by Col. George W. Shults, a highway designer, is nevertheless applicable to all routes where vertical curves are desirable. The range of vertical curves covered by this publication is from 10 ft to 2,000 ft. Corrections may be figured for any point on the curve. **E-Z-V-C Tables, Sta. "F," Atlanta, Ga.**

ENGINEERING SERVICE BOOKS—"Outline of Procedure in Bearing Application" is the fifth of a series of Engineering Service books by New Departure, Div. of General Motors Corp. It gives, in 20 pages, a brief outline of the principal steps required in developing a successful ball bearing mounting. In describing these steps, frequent marginal references are made to make it easier to gather additional data from other books in the series which cover those subjects in more detail. This book should be helpful to designers who may be called upon to make provisions for bearings of this kind in a variety of products. **New Departure, Div. of General Motors Corp., Bristol, Conn.**

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LOCKED IN THE ROCK

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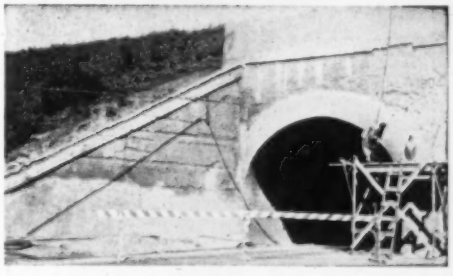
"GUNITE" CONTRACTORS
GENERAL OFFICES—ALLENTOWN, PENNA., U.S.A.



RAILROAD BRIDGE REPAIRED WITH "GUNITE."

This is one of the many bridges we have repaired with "GUNITE" for the R. F. & P. Railroad between Richmond and Washington.

This double-arch overpass built in 1904 was showing its age and after chipping away all disintegrated concrete and sand-blasting, mesh reinforced "GUNITE" at least 2" thick was applied to both arch barrels, end walls, and wing walls. The end walls in this case were also raised three feet with "GUNITE" to eliminate troublesome slipping of ballast.

"GUNITE" repairs to structures of this type will restore them for a great many years of useful, safe service.

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Literature Available (Cont.)

TRUCK MIXER CATALOG—The Hi-Discharge Moto-Mixer manufactured by the Chain Belt Co. is explained fully in an illustrated bulletin. Features discussed include: the patented Hi-Lo visible mixing action, the new water nozzle for proper placement of mixing water, 3 point drum suspension and the cushioning chain drum drive, twin-clutch transmission, and the Rex discharge system with its many spout arrangements. A complete list of specifications completes the bulletin. **Chain Belt Co., Milwaukee, Wis.**

CORROSION BULLETIN—Causes and control of corrosion and contamination in the chemical industry are thoroughly discussed in a new 4-page bulletin recently released. Completely covering the chemical field from pharmaceuticals to explosives, the bulletin is factual, concise and easy to read. How to prevent corrosion of acid tanks, fume ducts, chemical piping, tank cars, floors and buildings are but a few of the surfaces discussed. All recommendations are made on the basis of actual experience and convincing evidence. **Amercoat Div., American Pipe & Construction Co., Los Angeles, Calif.**

ELEVATED WATER TANKS—"Horton Ellipsoidal-Bottom Elevated Water Tanks of Welded Construction" is the title of a new bulletin. Horton elevated tanks are used to provide gravity water pressure for general service or fire protection. The new bulletin contains illustrations of 7 different sizes of tanks. These illustrations are reproduced in full color, picturing the pleasing appearance and streamline design of welded construction. There is also a page of construction details. **Chicago Bridge & Iron Co., Chicago, Ill.**

MATHEMATICAL INSTRUMENT—A sheet of 2 pages describing The Jacob Integraph is now available. This sheet shows cuts of 2 forms: Type 1, a 6-in., 45-deg triangle, and type 2, an attachment for drafting machines. Type 1, made by a precision instrument manufacturer, will soon be available with an instrument book. Some specimen pages of this book are shown. The Jacob Integraph provides a means of applying graphical calculus to problems without limit. Integraph and differential curves can readily be drawn. **Brent C. Jacob, 205 N. Mountain St., Bay City, Mich.**

CRUSHER AND PROCESS MACHINERY—Publication of two new bulletins by the Crusher and Process Machinery Divisions of The Norberg Mfg. Co. is announced. Bulletin 149, "Nordberg Machinery for Processing Ores and Minerals," is an 8-page pamphlet illustrating and giving a general description of 21 different machines. Bulletin 152 is a 4-page pamphlet giving in some detail the advantages and special design features of Nordberg Grinding Mills of the ball, pebble, rod, tube and compartment types. **The Norberg Mfg. Co., Milwaukee, Wis.**

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